1. Bacillus of Tetanus, with Spores. 2. Gonococci in Gonorrhœal Pus (aniline, methyl-violet). 3. Tubercle Bacilli in Sputum (Ziegler). 4. Hutchinson Teeth. 5, 6. Radial Pulse-tracings in Aneurysm of Right Brachial Artery: 5, left radial pulse; 6, right radial pulse.

Saunders' New Aid Series

A MANUAL OF MODERN SURGERY

GENERAL AND OPERATIVE

BY

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THIS VOLUME IS

DEDICATED, WITH AFFECTIONATE REGARDS, TO

DR. ORVILLE HORWITZ,

THE FELLOW-STUDENT, THE HOSPITAL ASSOCIATE, AND
THE TRUSTED FRIEND OF

THE AUTHOR.

PREFACE.

The aim of this Manual is to present in clear terms and in concise form the fundamental principles, the chief operations, and the accepted methods of modern surgery. The work seeks to stand between the complete but cumbrous text-book and the incomplete but concentrated compend.

Obsolete and unessential methods have been excluded in favor of the living and the essential. There has been no attempt to exploit fanciful theories nor to defend unprovable hypotheses, but rather the effort has been to present the subject in a form useful alike to the student and to the busy practitioner.

The opening chapter is devoted to Bacteriology because the author profoundly believes that without some knowledge of the vital principles of this branch of science the vast importance of its truths will be ill-appreciated, and there will be inevitable failure in the application of aseptic and antiseptic methods.

Ophthalmology, gynecology, rhinology, otology, and laryngology have not been considered, because of the obvious fact that in the advanced state of specialized science only the *specialist* is competent to write upon each of these branches.

In Orthopedic Surgery are discussed those conditions which must in the very nature of things often be cared for by the surgeon or the general practitioner (such as hip-joint disease, club-foot, Pott's disease of the spine, flat-foot, etc.). The limited space at command precluded the introduction of a special division on diseases of the female breast. A large amount of space has been devoted to Fractures and Dislocations, the enormous practical importance of these subjects calling for their full discussion. Operative Surgery is

considered in separate sections, the most important procedures being fully described, giving also the instruments necessary, and the positions assumed by patient and operator. This method has been adopted to fit the work for use in surgical laboratories.

Many systems, manuals, monographs, lectures, and journal articles have been consulted, and credit has been given in the text for statements and quotations. Special acknowledgment is due to the *American Text-Book of Surgery*, edited by Keen and White; to the surgical works of Ashurst, Agnew, the elder Gross, Duplay and Reclus, Esmarch, Albert Koenig, Wyeth, and Bryant; to the *Manual of Surgery* edited by Treves; to the *International Encyclopædia of Surgery* edited by Ashurst; to the *Surgical Pathology* of Billroth and of Bowlby; to the *Diagnosis* of E. Pearce Gould; to the *Surgical Dictionary* of Heath; to the *Rest and Pain* of Hilton; to the works on operative surgery of Barker, Jacobson, Treves, Stephen Smith, and Joseph Bell; to the *Minor Surgery* of Wharton; to the dictionary of Foster and of Gould; to the *Principles of Surgery* of Senn; to the orthopedic writings of Sayre; to the work on *Diseases of the Male Generative Organs* of Jacobson; to the *System of Genito-urinary Diseases* edited by Morrow; and to the treatises on *Fractures and Dislocations* of Sir Astley Cooper, Malgaigne, Hamilton, Stimson, and T. Pickering Pick.

The Author returns his thanks to the numerous writers who courteously authorized the reproduction of special illustrations, and particularly to Professors Keen and White for their free permission to draw upon the *American Text-Book of Surgery*, from which a number of pictures have been taken, distinctively those referring to Bandaging; to Mr. John Vansant for the great amount of labor so ably and cheerfully performed; and to Dr. Howard De Honey for the preparation of the Index.

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A Manual of Surgery.

I. BACTERIOLOGY.

Bacteriology is the science of micro-organisms. Though a science in the youth of its years, bacteriology has not only profoundly altered, but it has also revolutionized, pathology, and our views of surgery will be incomplete, misleading, and erroneous without its aid.

Micro-organisms, microbes, or **bacteria** are minute vegetable cells of the class *fungi*, many of them being visible only by means of a highly powerful microscope after they have been brightly stained. The contents of these cells is protoplasm enclosed by a structure like cellulose. The protoplasm can be stained by aniline colors, and the cell-wall is more readily detected after treating it with water, which causes it to swell. Many of these organisms are colored, others are colorless. Some move (motile bacteria), others do not move; among the motionless ones may be mentioned the bacilli of anthrax and tubercle.

Definite knowledge of these minute bodies and of their actions dates from the study of fermentation by the celebrated Frenchman, Pasteur, who in 1857 asserted that every fermentation has invariably its own specific ferment; that this ferment consists of living cells; that these cells produce fermentation by absorbing the oxygen of the substance acted upon; that putrefaction is caused by an organized ferment;

that all organized ferments are carried about in the air; and that to entirely exclude air prevents putrefaction or fermentation. These statements, which were radical departures from accepted belief, inaugurated a bitter controversy, and in that controversy were born the microbic theory of disease, the doctrine of preventive inoculation, and antiseptic surgery.

The word *microbe*, which signifies a small living being, was introduced in 1878 by the late Professor Sédillot of Paris. At that time the nature of these bodies was in doubt; some thought them animal, and called them *microzoaria;* others thought them vegetable, and called them *microphyta;* the designation "microbe" does not commit us to either view. We now know them to be vegetable, but the term "microbe" has remained in use.

The *fungi* connected with disease in man are divided into three classes:

1. Yeasts, or Blastomycetes;
2. Moulds, or Hyphomycetes;
3. Bacteria, or Schizomycetes.

Yeasts are small cells which multiply by gemmation, these cells often sticking together and forming branches, and containing spores when nourishment is insufficient. They are thought to be vegetative forms of higher *fungi* (Green). The chief importance of these cells is that they cause fermentations; they never invade human tissues. Yeasts may dwell on mucous membranes, and even in the stomach. *Oïdium albicans* is an yeast-fungus whose growth upon the mucous membranes of the mouth, pharynx, and œsophagus causes the disease known as "thrush."

Moulds consist of filaments, each filament being composed of a single row of cells arranged end to end, and all filaments springing from a germinal tube which grows from a germinating spore. Moulds are largely connected with processes of decay. Some of them can grow upon inflamed

mucous membrane; some invade the epidermis, producing certain skin diseases (favus, tinea tonsurans, tinea versicolor, etc.).

Actinomycosis and Madura-foot arise from the lodgment and growth of moulds (Fig. 1). Actinomycosis is a disease seen in cattle, and occasionally in men, especially in drovers. Cattle become infected through their food, the fungus entering by a hollow tooth or by a breach in continuity. The lower jaw is usually the seat of involvement (lumpy jaw). A tumor forms, which contains sero-pus, and after a time ruptures and discharges. The matter contains nodules of fungi. The bone may undergo extensive destruction. Other bones and various organs can be infected. Iodide of potassium will sometimes bring about a cure. Extensive operations may be demanded.

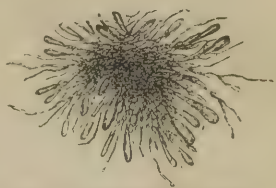


FIG. 1.—Actinomyces (Ziegler).

Bacteria chiefly claim our attention. It is important to remember that the term "bacteria," though applied to the class *schizomycetes*, has also a more restricted application—that is, to a division of the class; it may either mean *schizomycetes* in general, or rod-shaped *schizomycetes*, whose length is not more than twice their breadth.

Some of the *schizomycetes* induce certain fermentations; others are productive of putrefaction, and are called *saprophytes;* still others, known as the *pathogenic*, cause various diseases. They vary much in shape, size, color, and arrangement. One form cannot be transformed into another, but each maintains its own specific identity. Every organism comes from a pre-existing organism, this being true of all forms, and spontaneous generation is impossible.

Forms of Bacteria.—The three chief forms of bacteria are—

1. The *Coccus*—berry-shaped or round bacterium (Fig. 2);
2. The *Bacillus*—rod-shaped bacterium (Fig. 3);
3. The *Spirillum*—corkscrew-shaped bacterium (Fig. 4).

FIG. 2.—Micrococcus.

FIG. 3.—Bacillus.

FIG. 4.—Spirillum.

De Bary compares these forms, respectively, with the billiard-ball, the lead-pencil, and the corkscrew.

Cocci.—We only have to do with *cocci* and *bacilli.* Cocci may be named according to their arrangement with one

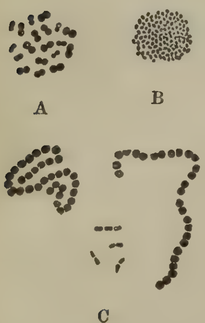


FIG. 5.—Forms of Bacteria.

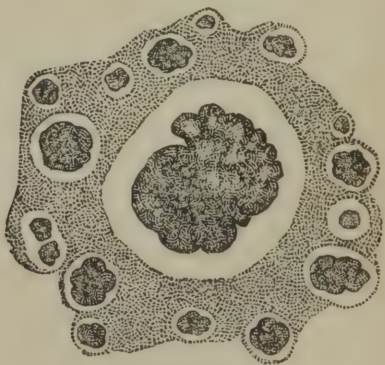


FIG. 6.—Zoöglœa (Ball).

another, namely: in pairs they are called *diplococci* (Fig. 5 A); in a chain they are called *streptococci* (Fig. 5 C); in a cluster like a bunch of grapes they are called *staphylococci* (Fig. 5 B); and in an irregular mass, stuck together by a thick substance, they constitute a *zoöglœa* (Fig. 6).

The cocci are often named according to their function, as, for example, "pyogenic," or pus-forming. The name may

embody the form, arrangement, color, and function; for instance, *staphylococcus pyogenes aureus* signifies a round, golden-yellow micro-organism, which arranges itself with its fellows into the form of a bunch of grapes, and which produces pus.

Multiplication of Bacteria.—Bacteria multiply with great rapidity when placed under suitable conditions. They can multiply by fission or by spore-formation. Some bacteria multiply by both methods. In fission, or segmentation, the cell elongates and about its middle a constriction begins, which deepens until the cell has divided into two parts,

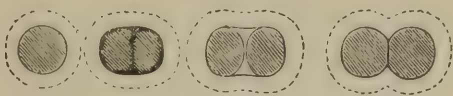


FIG. 7.—Divisions of a Micrococcus (after Macé).

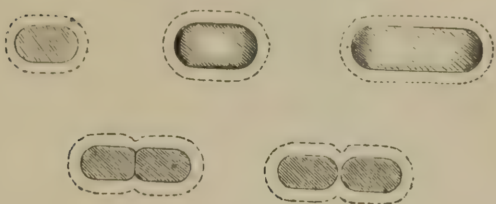


FIG. 8.—Divisions of a Bacillus (after Macé).

each of which soon grows as large as its parent (Figs. 7, 8). All cocci and some bacilli multiply by this method. If segmentation of a single cell and the growth to maturity of its products require one hour (it really takes place in less time), a single cell in a single day will have sixteen million descendants (Cohn).

Spores.—A *spore* is a germ, and corresponds with the seed of a plant. Most of the bacilli multiply by spore-formation. When spore-formation is about to occur in a bacillus, points

of cloudiness appear in the protoplasm, the cell generally elongates, and in twenty-four hours the cell is found to consist of a series of segments like a necklace of beads, each segment containing a full-grown spore (Fig. 9). The wall of the cell now liquefies, the segments separate, the spores are set free, and each spore, under favorable conditions, becomes a bacillus. When the initial cloudiness appears in the middle of the cell, it is called an "endospore;" when it appears at one or both extremities, it is christened an "endspore" or "endspores." When multiplication is by a single endospore, the bacillus does not elongate.

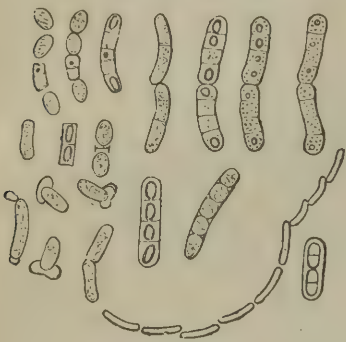


FIG. 9.—Sporulation (after De Bary).

Life-conditions of Bacteria.—In order to grow and to multiply, bacteria require suitable soil and the favoring influences of heat and moisture. The soil demanded consists of highly-organized compounds rather than crude substances, and slight modifications in it may prove fatal to some forms of bacterial life, but highly advantageous to others. The fluids and tissues of the individual may or may not afford favorable soil for the germs of disease, or, in the same person, may afford it at one time, and not at another. Some individuals seem to possess indestructible immunity from, and others are especially prone to, certain contagious diseases. Impairment of health, by altering some subtle condition of the soil, may make a person liable who previously was exempt. All organisms require water. If dried, no form will multiply, and many forms will die.

The presence of oxygen effects microbic growth. Most

organisms thrive best when exposed to the oxygen of the air, and they are known as "aërobic." The term "anaërobic" is employed to designate organisms that can live without free oxygen; they require this gas, but are capable of extracting it from its combinations in tissues. An organism which can grow indifferently where oxygen is plenty or where free oxygen is absent is called a "facultative-aërobic" bacterium. A sensitive organism which dies when the amount of oxygen is even slightly diminished is called an "obligate-aërobic" bacterium. Most microbic diseases in man are due to facultative-aërobic bacteria.

Effect of Heat and Cold.—Most *fungi* grow best when at rest; agitation retards the growth of some and kills others. Temperature is of importance to bacterial growth. Some organisms will only grow within narrow temperature limits, while others can sustain sweeping alterations, but most grow best between the limits of from 86° to 104° Fahrenheit. Freezing renders bacteria motionless and incapable of multiplication, but it does not kill them: they again become active when the temperature is raised. The absurdity of employing cold as a germicide is evident when the fact is known that a temperature of 200° F. below zero is not fatal to germ-life, its activities only being rendered dormant. High temperatures are fatal to bacteria; moist heat is more destructive than dry heat, and adult cells are more vulnerable than spores. A temperature less than 212° F. will kill many organisms, and boiling will kill every organism that does not form spores. Some spores are not destroyed after prolonged boiling, and some will withstand a temperature of 120° C. As a practical fact, however, boiling water kills, in a few minutes, all cocci, most bacilli, and many spores; though the spores of anthrax, tetanus, and malignant œdema are not with certainty destroyed. Sunlight antagonizes some forms of bacterial growth.

Chemical Germicides.—Many chemical agents will kill bacteria, the most certain of them all being corrosive sublimate. Koch showed that corrosive sublimate is an efficient germicide when present in the proportion of only 1 part to 50,000. It is used in surgery in strengths of 1 part of the salt to 1000, 2000, 3000 or more parts of water. Because of the fact that contact with albumin precipitates from a solution of corrosive sublimate an insoluble albuminate of mercury, in surgical operations by the wet method considerable quantities must be used; or the mercury is combined with tartaric acid in the proportion of 1 to 5, which combination prevents the insoluble albuminate from being formed.

Carbolic acid is a valuable germicide in the strength of from 1:40 to 1:20. It is certainly fatal to pus-germs. Unfortunately, this acid attacks the hands of the surgeon; consequently in the United States it is chiefly employed as an antiseptic medium in which to place the operating-instruments. Iodoform is largely used; it is not truly a germicide, as bacteria will grow upon it, but it hinders the development of bacteria and directly antagonizes the toxic products of germ-life. Kreolin, which is a preparation made from coal, is a germicide without irritant or toxic effects. It is less powerful than carbolic acid, and is used in an emulsion of a strength of from 1 to 5 per cent. Peroxide of hydrogen is a most admirable agent for the destruction of pus cocci. It comes in a 15-volume solution, which is diluted one-half or two-thirds. It probably destroys the albuminous element upon which the bacteria live. The peroxide of hydrogen is not fatal to tetanus bacilli.

Distribution.—Microbes are very widely distributed in nature. They are found in all water except that which comes from very deep springs; in all soil to a depth of 3 feet; and in air, except that of the desert, on the open sea, and on lofty mountains.

Microbes may be useful. Some of them are scavengers, and clean the surface of the earth of its dead by the process known as "putrefaction," in which complex organic matter is reduced to harmless gases and to a mineral condition, the gases being taken up from the air by vegetables, and the mineral matter dissolving in rain-water and passing again into the soil from which it came, there again to be food for plants which become food for animals. Other organisms purify rivers; others again cause bread to rise; still others give rise to fermentation in liquors. Microbes may be harmful. They may poison rivers and soils; they may be parasites on vegetable life; they cause disease of the grape and wine; they mould bread; they poison sausage and canned foods; and they produce many diseases among men and the lower animals.

With so universal a distribution of these *fungi*, man must constantly take them into his organism. They are upon the surface of his body, he inhales them with every breath, and he swallows them with his food and drink. Most of them, fortunately, are entirely harmless; others cannot act on the living tissues; but some are virulent, and these are generally destroyed by the cells of the human body. The alimentary canal always contains bacteria of putrefaction, which act only upon the dead food, and not upon the living body; but when a man dies these organisms at once attack the tissues, and post-mortem putrefaction begins in the abdomen.

Koch's Circuit.—To prove that a microbe is the cause of a disease it must fulfil Koch's circuit. It must always be found associated with the disease; it must be capable of forming pure cultures outside the body; these cultures must be capable of reproducing the disease; and the microbe must again be found associated with the morbid process.

When disease-producing organisms enter the body, they are usually rapidly destroyed; they cannot dwell there

long without inducing disease, but spores can lie dormant in the system for years, only waking into activity when they come in contact with some damaged, weakened, or diseased part—a so-called point of least resistance (a *locus minoris resistentiæ*)—which affords a nest for them to develop and to multiply, the cellular activities of the weakened part being unable to cope with the organism. Even large doses of pathogenic organisms may induce no trouble in a healthy man; but let them reach a damaged spot, and mischief is apt to arise. Kocher established subcutaneous bone-injuries in dogs, and these injuries pursued a healthy course until the animal was fed upon putrid meat, whereupon suppuration took place. This experiment proves that an organism can reach a damaged area by means of the blood, and it enables us to understand how a knee-joint can suppurate when we merely break up adhesions, and how osteo-myelitis can follow trauma when the skin is intact.

Toxalbumins and Toxines.—The action of pathogenic bacteria upon the tissues is of great importance. In the first place, they abstract from the blood, the lymph, and the cells certain elements necessary to the body—as water, oxygen, albumins, carbohydrates, etc.—and bring about body-wasting and exhaustion from want of food. In the second place, bacteria produce a series of compounds, some harmless and others highly poisonous. These organisms contain and secrete ferments like pepsin or trypsin, and as albumoses are formed in the alimentary canal by the digestive ferments, which split up proteids, sugars, and starches, we have microbic albumoses. Just as the albumoses formed in digestion are poisonous when injected, so are the albumoses of microbic action, and they are called "toxalbumins." These albumoses often operate as virulent poisons to the body-cells.

Another assemblage of compounds formed by the microbic destruction of tissue is designated the group of "toxines."

These toxines are poisonous alkaloids which are readily diffusible and, many of them, very virulent. It is probable that every pathogenic organism has its own special toxine which produces its own characteristic effects. The absorption of toxines may be very rapid; for instance, the toxines of cholera may kill a man before the bacillus has migrated from the intestine.

Ptomaïnes.—By many writers the term "ptomaïne" is used to designate these toxines, but in reality a ptomaïne is a form of toxine that is due to the action of saprophytic bacteria. A ptomaïne is a putrefactive alkaloid, and a toxine is any poisonous alkaloid of microbic origin. Among these poisonous alkaloids may be mentioned tetanine, typhotoxine, sepsine, putrescine, muscarine, and spasmotoxine.

Leucomaïnes must not be confounded with the above-mentioned bodies. Leucomaïnes are alkaloid substances existing normally in the tissues, and arising from physiological fermentations or retrograde chemical changes. They are natural body-constituents, in contrast to toxines, which are morbid. Leucomaïnes are found in expired air, saliva, urine, various tissues, and the venom of serpents. If not excreted, these bodies can induce illness, and when injected can act as poisons. Ordinary colds and some fevers result from leucomaïnes; they play a great part in uræmia, and when excretion is deficient and leucomaïnes are retained they make the system a hospitable host for pathogenic bacteria. Among leucomaïnes may be mentioned adenine, hypoxanthine, and xanthine, allied to uric acid, and other substances allied to creatine and creatinine.

Antitoxines.—Another group of substances arising from microbic action are known as "antitoxines." It is a well-recognized fact in fermentation that after a time the process ceases, and the addition of more ferment is void of result. The same is true of specific maladies; thus, if a person

recovers, the organisms disappear, and the injection of more of them produces no result; in other words, immunity exists toward the disease. This immunity was long believed to arise from the exhaustion of some unknown constituent of tissue necessary to the life of the bacteria. It is now believed to be due partly to the capacity of the amœboid cells to destroy germs, and partly to the production of antitoxines which, when they have developed in sufficient amount, destroy the cells that made them. In other words, the fact seems to be established that bacteria not only produce poisons, but also the antidotes for them.

Phagocytes.—The tendency of the white blood-cells and of the fixed tissue-cells to destroy organisms is undoubted. This process of destruction is known as "phagocytosis," and the destroying cells are called "phagocytes." These cells try to eat up and destroy the germs. A battle-royal occurs,

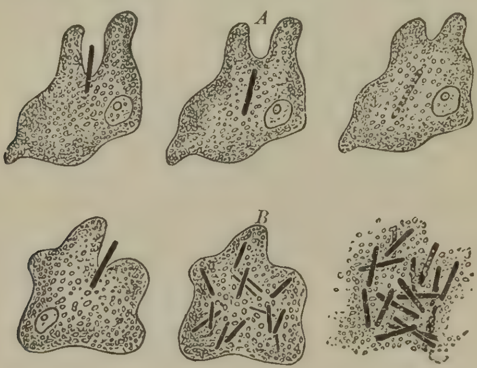


FIG. 10.—Phagocytosis: A, successful, B, unsuccessful (Senn).

the microbe fighting the body-cells with most active ferments, the body-cells endeavoring to devour and engulf the bacteria (Fig. 10). In some cases the bacteria win absolutely and the patient dies. In other cases they win for a time and overwhelm the organism, but presently the body-cells, whose

movements were inhibited by poison, regain their activity and successfully recur to the attack. After the attack is over the body-cells have been educated to withstand this poison, and their descendants retain this capacity; the weak cells were killed, the fittest survived, and the descendant cells of the survivors are born insusceptible. This is *immunity*, and lasts for a varying period. Some persons seem, from birth, immune to certain maladies. The theory of phagocytosis immunity assumes an educated white corpuscle and body-cell. This view originated with Sternberg, but it is usually accredited to Metschnikoff.

Protective and Preventive Inoculations.—Our knowledge of protective inoculations for contagious diseases dates from Jenner's discovery in 1768. Preventive inoculations with attenuated virus are due to the experiments of Pasteur. This observer discovered the cause of chicken-cholera, and he cultivated the micro-organism of this disease outside the body. He found that by keeping his cultures some time they became attenuated in virulence, and that these attenuated cultures, inoculated in fowls, caused a mild attack of the disease, which attack was protective, and rendered the fowl immune to the most virulent cultures. Cultures can be attenuated by keeping them for some time, by exposing them for a short period to a temperature just below that necessary to kill the organisms, and by treating them with certain antiseptics. It has further been shown that injection of the blood-serum of an animal rendered immune by inoculation is capable of making a susceptible animal also immune.

A most important fact is that animals may be rendered immune by inoculating them with filtered cultures, the filtrate containing microbic products, but not living microbes. By this method animals can be rendered immune to tetanus and diphtheria. Pasteur's protective inoculations against hydrophobia owe their power to microbic products, and

Koch's lymph contains them as its active ingredients. The chief feature in acquired immunity is the presence in the blood of elements which can neutralize the toxic products of bacteria. These elements are called "antitoxines," or defensive proteids. The present knowledge of them arose from the discovery of Nuttall and Buchner that fresh blood-serum is germicidal, the power varying for different bacteria and being limited, for a fixed amount of serum is capable of destroying a small dose of bacteria only. It has been shown that in tetanus injections of the serum of an immune animal can cure the disease. The above facts are of immense importance, for on these lines will be solved the prevention and treatment of microbic maladies.

Antagonistic Microbes.—Another observation of importance is that certain microbes are antagonistic to one another. The streptococcus of erysipelas attacks the organism of anthrax. We should note also that the growth of some microbes affects the soil favorably or otherwise for the growth of others, and the same may be true in the body.

Mixed Infection.—A fact of practical importance to the surgeon is that an area infected by one form of pathogenic organism may be invaded by another form. This is known as a *mixed* infection, and consists of a *primary* infection with one organism, and a *secondary* infection with another. Koch found both bacilli and micrococci in the same lesion of tubercle. A soil filled with pneumococci is favorable to the growth of pus cocci and tubercle bacilli. Tuberculous and syphilitic lesions may be attacked by erysipelas. Chancre and chancroid can exist together. A syphilitic ulcer is a good culture for tubercle bacilli (Schnitzler). Suppuration in erysipelas or tuberculosis means a secondary infection with pus cocci.

Placental Transmission.—The direct transmission of bacteria from parents to fœtus is a problem still in course of

solution. Certain it is that some diseases (as syphilis) are due to the direct carrying of the microbes by sperm-cell to germ-cell, or to the transmission of the micro-organism through the septum of separation between the circulations of the mother and child. In many other diseases the microbe is not directly transmitted (as in phthisis), but a patient born with weakened tissue-cells is prone to fall a prey to the latter malady.

Special Surgical Microbes.—*Pus microbes*, or *pyogenic microbes*, include the following forms:

1. *Staphylococcus pyogenes aureus* (Fig. 11), which is the commonest form, is killed by a few minutes' boiling, by corrosive sublimate, or by carbolic acid. These microbes are very widely distributed in the soil, air, and water, in the

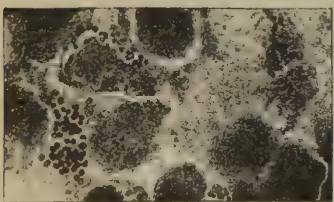


Fig. 11.—Staphylococcus Pyogenes Aureus in Pus (× 1000) (Fränkel and Pfeiffer).

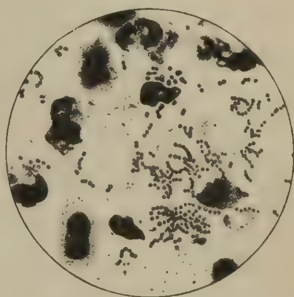


Fig. 12.—Streptococcus Pyogenes in Pus (× 1000) (Fränkel and Pfeiffer).

superficial layers of the skin, especially the axillæ and the region of the perineum, and are found in the mouth, pharynx, alimentary canal, and under the nails.

2. *Staphylococcus pyogenes albus.*

3. *Staphylococcus pyogenes citreus.*

4. *Streptococcus pyogenes*, which is found normally in the nose, saliva, vagina, and urethra (Fig. 12).

5. *Bacillus pyocyaneus*, which exists in blue pus.

These pyogenic cocci subsist in all acute abscesses. The *staphylococci* exist in circumscribed suppurations, as in boils and carbuncles; the *streptococci*, in spreading inflammations, as in erysipelas and cellulitis.

Can suppuration exist without cocci? It can, but practically does not. The injection of irritants may form a thin fluid resembling pus, but containing no bacteria. The products of bacterial action when injected will form pus. But practically in surgery to exclude cocci is to prevent the formation of pus. Cocci form pus by liquefying inflammatory products or tissues. Cold abscesses are due to tubercle bacilli, and they do not contain pus cocci unless mixed infection exists.

Other Surgical Microbes.—*Streptococcus erysipelatis* resembles *streptococcus pyogenes*, and they are thought by many to be identical. Their difference in action is considered to be due to difference in virulence induced by external conditions and the state of the tissues.. The *gonococcus*, or Neisser's bacillus, is a *diplococcus*, and is the specific organism of gonorrhœa (Pl. 1, Fig. 2). The *tetanus bacillus*, or the bacillus of Nicolaier, exists chiefly in the soil of gardens, in manures about stables, and in masonry (Pl. 1, Fig. 1). The *bacillus tuberculosis*, or Koch's bacillus, the cause of all tuberculous processes, exists particularly in air infected by the dried sputum of tuberculous subjects. This infected air is the chief means of its transmission. It is found also

FIG. 13.—Anthrax Bacilli in Blood (Vierordt).

in the milk of tuberculous cows. Such milk can spread the disease (Pl. 1, Fig. 3). The *bacillus œdematis maligni* gives rise to malignant œdema. The bacillus of syphilis, or Lustgarten's bacillus, is not definitely determined to be the cause of syphilis. The *bacillus mallei* is the bacillus of glanders. The *bacillus anthracis* is the bacillus of anthrax, splenic fever, wool-sorter's disease, or malignant pustule (Fig. 13). The *ray fungus* causes actinomycosis. *Streptococci* are found in noma. No specific organism has been isolated for traumatic spreading gangrene or hospital gangrene; only pus cocci have been found. The bacterium coli communis is the supposed cause of peritonitis (*q. v.*).

II. INFLAMMATION.

Definition.—Inflammation is a nutritive disturbance arising from tissue-damage, and is not an increase of nutrition. It is defined by Burden-Sanderson as "the succession of changes which occur in a living tissue when it is injured, provided that the injury is not of such a degree as at once to destroy its structure and vitality." The changes alluded to in this definition comprise—(1) changes in the vessels and the circulation; (2) exudation of fluids and solids from the vessels; and (3) changes in the perivascular tissues.

Vascular and Circulatory Changes are essential to inflammation in both vascular and non-vascular tissues. In the former they occur in the tissues; in the latter (cornea and cartilage) they are manifest in neighboring tissues from which the non-vascular area derives its nutritive material.

Active Hyperæmia.—When an irritant is applied to tissue, there may be a momentary arterial contraction due to irritation of the nerves, but this contraction is transitory, and is not an inflammatory phenomenon. The first vascular phenomenon is dilatation of all the vessels—capillaries,

venules, and arterioles—appearing first, and being most pronounced, in the small arteries. As a result of this dilatation there is increased rapidity of circulation and increased determination of blood to the part. This condition of increased circulatory activity is known as "active hyperæmia" (Fig. 15).

Retardation.—During active hyperæmia the capillaries are crowded with corpuscles and the blood in the veins is of a much brighter red than in health. The red blood-cells are swept along the centre of the current (in the axial stream), the white blood-cells float lazily along near the vessel-wall. After a variable time the blood-current begins to slow down until it becomes more tardy than in health.

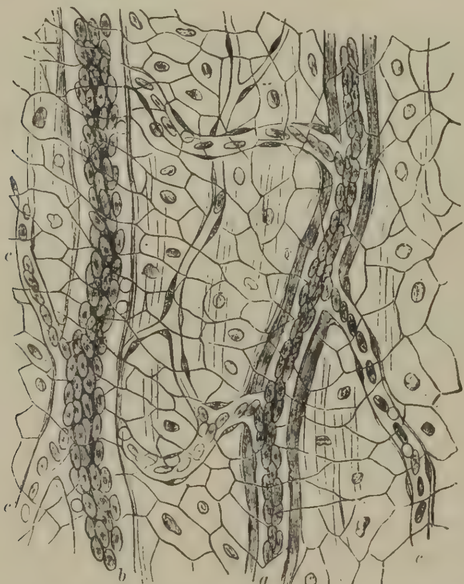


FIG. 14.—Normal Vessels and Blood-stream: *a*, artery; *b*, vein; *c*, capillary (Landerer).

This is known as "retardation of the circulation." Retardation is first noted in the capillaries, next in the venules,

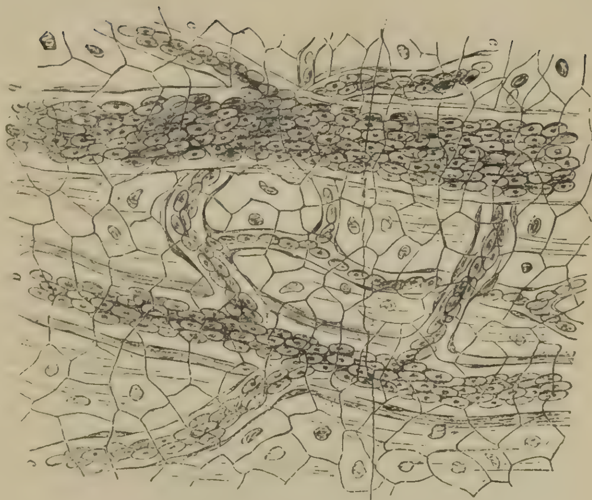


FIG. 15.—Dilatation of the Vessels in Inflammation: *a*, artery; *b*, vein; *c*, capillary (Landerer).

FIG. 16.—Stasis of Blood and Diapedesis of White Corpuscles in Inflammation: *a*, artery; *b*, vein; *c*, capillary (Landerer).

and last in the arterioles; but arterial pulsation continues. The white cells show a strong tendency to adhere to the vein-walls, and, as a result, accumulate against the inside of, and stick to, these walls and to one another until the veins are entirely lined with layers of *leucocytes.* In the capillaries some leucocytes gather, but not many. In the arteries they try to adhere during cardiac dilatation, but are swept away by the force of the heart's contraction.

Oscillation and Stagnation.—By this accumulation of leucocytes the blood-stream is progressively narrowed and the axial current is impeded. The red blood-cells begin to stick to one another, forming aggregations like *rouleaux* of coin, which increase the difficulty the axial current has to contend with, until progressive movement ceases and the contents of the vessels sway to and fro with the pulse. This is the stage of *oscillation.* In a short time oscillation ceases and the vessels are filled with blood which does not move. This is known as "stasis" or "stagnation." If stasis persists, we get coagulation or thrombosis. We can then sum up the vascular changes of inflammation by stating that they consist in a dilatation of the vessel-walls, in a primary acceleration, a secondary retardation, and a subsequent stagnation of the blood-current with adhesion of leucocytes to the walls of veins and capillaries, and in the aggregation into masses of the red blood-cells (Fig. 16).

Exudation of Fluids.—It is to be remembered that in ordinary nutrition serum and white cells pass into the tissues through the walls of vein and capillary. In inflammation the same thing happens, but the exudation is vastly greater in amount and is different in composition. In any slight inflammation, and in the early stages of any inflammation, there is an increase in the serous exudate, and we speak of the condition as "serous inflammation." This fluid is really not serum, but is liquor sanguinis. We find serum

in passive congestion, not in active hyperæmia. It contains very few white cells. If the inflammation goes no further, the exuded serum is drunk up by the lymphatics. A blister is an example of serous inflammation. If the inflammation continues to intensify, the exudation is altered in character—it becomes thicker, turbid, and very coagulable. It contains white cells and fibrin elements, and coagulates in the tissues. This fluid is known as "lymph" or plastic exudation, and when it is present we speak of the condition as "plastic inflammation." The lymphatics endeavor to absorb the fluid, but it occludes them by coagulation, and the area they drain becomes swollen, hard, and "branny." This lymph can be seen in the anterior chamber of the eye in cases of plastic iritis.

Diapedesis or Migration.—Even early in an inflammation some few white corpuscles pass through the vessel-walls; but when the inflammation is well established large numbers pass, and when it is severe, vast hordes. This process is known as "diapedesis" or "migration." The leucocytes throw out protoplasmic arms, insert themselves between the cells of the walls, and pull themselves through by their amœboid movements. They do not pass through existing open doors, but form openings which close after them. This is readily accomplished, because the vessel-wall is itself damaged, weakened, and convoluted. This escape of leucocytes takes place chiefly from the venules, though some migrate through the capillaries and arterioles (Fig. 17).

In very acute inflammation the vessel-walls are so damaged that red corpuscles also escape, making the tissue appear as if infiltrated with blood. The white corpuscles greatly increase in number in the blood of a person who has an acute inflammation, and the blood-making organs, such as the spleen and lymphatic glands, are often enlarged. The blood-plaques or third corpuscles are found to be pres-

ent in increased numbers. These blood-plaques are not seen in moving blood, but are found in blood-clot, their usual proportion to red cells being as 1 to 20, and they are especially numerous at the height of fever processes and during convalescence from an extensive abscess.

Changes in the Perivascular Tissues.—The exuded liquor sanguinis coagulates, and as a result of the exuda-

FIG. 17.—Stages of the Migration of a Single White Blood-corpuscle through the wall of a vein in two hours and ten minutes (mesentery of the frog) (Caton).

tion of elements of the blood the tissues are softened, separated, and overfed. The abundance of food causes them to multiply, and this is known as "cell-proliferation." To the proliferating cells of the perivascular tissues are added the migrated leucocytes, and we soon get a mass of small round or oval cells, held together by gelatinous intercellular material, called "embryonic tissue," inflammatory or organized new formation, or plastic infiltration. The tissues have reverted to a condition identical with those of the embryo as the first step in repair. The above complicated processes are not accidents nor haphazard freaks, but are Nature's

efforts to bring about a cure. The acceleration of the circulation is an attempt to wash away offending material; when this fails, congestion is relieved by exudation and migration, the blood becoming albuminous and more corpuscular in order that foreign bodies may be encapsuled or extruded, so that damaged parts may be amply repaired and that vital structures may be protected and shielded.

Dilatation is due to the direct effect of the injury upon the muscle or its nerve-elements, and not to reflex action, as it occurs even when the nerves have all been divided. Retardation and stasis are due primarily to an altered condition of the vessel-wall, which caused resistance to the passage of the blood-stream and adhesion of the cells to the vessel. It may be increased secondarily by the pressure of an enormous exudate, producing tension. This tension may be so great as to produce sloughing.

Classification of Inflammations.—The various forms of inflammations are—(1) *Simple* or *common*, that which is due to any ordinary traumatic, chemical, or thermal cause, and not to bacteria, such as traumatic periostitis or sun dermatitis. It does not tend particularly to spread; (2) *infective* or *specific*, that which is due to micro-organisms, as erysipelas. An unsuccessful attempt has been made to charge all inflammations to bacteria. It is true that they can generally be found in inflammatory areas, but that they alone can be causative is accepted by but few. Infective inflammations tend to spread widely; (3) *traumatic*, which is due to a blow or an injury; (4) *idiopathic*, which is without an ascertainable cause. There is certainly a cause, however, even if it cannot be pointed out; (5) *acute*, which is rapid in course and violent in action; (6) *chronic*, which follows a prolonged course; (7) *subacute*, which is intermediate in violence and duration between acute and chronic; (8) *sthenic*, characterized by high action. Occurs in strong young subjects;

(9) *asthenic* or *adynamic*, occurring in the old, the debilitated, and the broken-down. It is unable to reach a sufficient degree to limit itself; (10) *parenchymatous*, affecting the "parenchyma," or active cells of an organ; (11) *interstitial*, affecting the connective-tissue stroma; (12) *serous*, characterized by profuse serous exudation, as in pleuritis, or by marked inflammatory œdema; (13) *plastic*, *adhesive*, or *fibrinous*, characterized by an exudation which glues together adjacent surfaces, as in peritonitis; (14) *purulent*, *phlegmonous*, or *suppurative*, when the pus cocci are present and multiply; (15) *hemorrhagic*, when the exudate contains many red blood-cells, as in strangulated hernia and in black small-pox; (16) *croupous*, when an inflammation produces upon the surface of a membrane a fibrinous exudate which cannot be organized (aplastic lymph), and which is due to the action of micro-organisms, usually on mucous membrane; (17) *diphtheritic*, which differs from croupous in the fact that the false membrane is in the tissue rather than upon it; (18) *gangrenous*, or death of the part, which occurs from tension of the exudate or from violence of the poison; (19) *healthy*, when the tendency is to repair; (20) *unhealthy*, when the tendency is to destruction; (21) *latent*, one which for some time does not announce itself by any obvious symptoms, as the inflammation of Peyer's patches in typhoid fever; (22) *contagious*, when its own secretions can propagate it; (23) *dry*, without exudation; (24) *hypostatic*, arising in a region of passive congestion (as a bed-sore); (25) *malignant*, due to malignant growths; (26) *catarrhal*, affecting mucous membranes; (27) *neuropathic*, due to impairment of the trophic functions of the nervous system, as in perforating ulcer; and (28) *sympathetic* or *reflex*, due to injury of a distant part, as when duodenal ulcer follows a surface-burn.

Extension of Inflammation.—Inflammation extends by continuity of structure, by contiguity of structure, by the

blood, and by the lymphatics. Extension by continuity is seen in phlebitis. Extension by contiguity is seen when a cutaneous inflammation advances and attacks deeper structures. Extension by the blood is seen in the formation of the small-pox exanthem. Extension by the lymphatics is witnessed in a bubo following chancroid.

Terminations of Inflammation.—Inflammation may terminate in a return of the tissues to health, and this return may take place by delitescence, by resolution, or by new growth. By *delitescence* is meant abrupt termination at an early stage, as when a quinsy is aborted by quinine, morphia, and a sweat; *resolution* means the gradual disappearance of the symptoms when inflammation has passed through its regular stages; and *new growth* means that an inflammation has had fibrinous exudation, has lasted a considerable time, with ample blood-supply and without suppuration. Inflammation may terminate in death of the inflamed part, or necrosis. Death of the part may be due to suppuration, ulceration, or gangrene.

The **causes of inflammation** are—*predisposing*, or those residing in the tissues, and rendering them liable to inflame; and *exciting*, or those which directly awake into activity. The first is the inflammable material, the second is the spark of fire.

Predisposing causes are those which impair the general vigor, injure the blood, weaken the tissues, or lower nutritive activities. Among these causes are shock, hemorrhage, nervous irritation, gout, rheumatism, diabetes, Bright's disease, and syphilis. Plethora renders a person liable to sthenic inflammations (those characterized by high action). Tissue-debility renders one prone to adynamic or asthenic inflammations.

Exciting Causes.—The exciting causes of inflammation are—*traumatic*, as blows, etc., and mechanical irritation; *chemical*, as the stings of insects, ivy poison, etc.; *thermal*,

heat and cold; and *specific*, the micro-organisms causing, for instance, tubercular peritonitis or erysipelas.

Symptoms.—Inflammation announces its presence by symptoms which are *local* and *constitutional.* The local symptoms are heat, pain, discoloration, swelling, and disordered function; the chief constitutional symptom is fever.

Local Symptoms of Inflammation.—The most prominent local symptoms were known centuries ago to the famous Roman Celsus, who stated them as "*rubor, calor cum tumore et dolore*"—redness and heat with swelling and pain. As set forth to-day, the local symptoms are—(1) heat; (2) pain; (3) discoloration; (4) swelling; and (5) disordered function.

Heat is due to the passage of an increased quantity of blood through the damaged area and to increased cellular activity. Although an inflamed part may be, and usually is, warmer than the surrounding parts, its temperature is never greater than the temperature of the blood. This increase of heat is especially noticeable when we contrast the feeling of an arm affected with erysipelas with a well arm: the diseased arm feels much warmer, but still its temperature is not above the general body-temperature. The extremities in health, as is well known, show on the surface a temperature below that of the blood; in an inflamed state their temperature may nearly equal that of the blood. Heat is always present in inflammation.

Pain is a constant and a conspicuous symptom. It is due to stretching of or pressure upon nerves from exudate; to irritation of nerves; or to inflammation in the nerves themselves, producing cellular changes. Pain varies in degree and in character. In serous membranes it is acute and lancinating, like dagger-thrusts; in connective tissue it is acute and throbbing; in large organs it is dull and heavy; in the bone it is gnawing or boring; in the skin it is itching

or stinging; in the urethra it is scalding; in the testicle it is sickening or nauseating; in the teeth it is throbbing; and in or under tense fascia it is pulsatile. Pain may alter its character. If a pain becomes markedly throbbing, it often means suppuration. Pain does not always occur at the seat of trouble, but may be felt at some distant point. This is known as a "sympathetic" pain, and means nervous communication, trouble with a nerve-trunk referring pain to the peripheral distribution.

Pain of hepatitis is often felt in the right shoulder. This pain at the point of the shoulder is felt also in gall-stones and in cancer of the liver. The pain arises in filaments of the pneumogastric from the hepatic plexus, which filaments reach the spinal accessory, pain being expressed in the branches of the spinal accessory which supply the trapezius and communicate with the third and fourth cervical nerves.[1]

Pain of coxalgia is often felt on the inside of the knee, because the obturator nerve, which sends a branch to the ligamentum teres, sends a branch to the interior and to the inner side of the knee-joint.

Inflammation of an eye with increased tension causes brow-ache. Inflammation of the neck of the bladder causes pain in the head of the penis. Inflammation of a testicle causes pain in the groin. Renal calculus causes pain in and retraction of the testicle, with pain in the thigh.

If the covering of an organ is involved, pain becomes more violent; for instance, a hepatitis becomes much more painful when the perihepatic structures are attacked. Inflammation without pain is known as "latent" (as the inflammation of Peyer's patches in typhoid). The sudden disappearance of inflammatory pain, when not due to opiates, means gangrene. The characteristics of inflammatory pain are that it comes on gradually, has a fixed seat, is attended by other

[1] Embleton's view in Hilton on *Rest and Pain*, a book every student should read.

inflammatory symptoms, and is increased by motion, by pressure, and by the hanging down of the part. If there be no tenderness in a part, the source of the pain is not local inflammation; but tenderness may exist when there is no local inflammation, as in pain referred from a distant part. Pain not corresponding to an exact nervous distribution is due to a local lesion. If pain corresponds exactly to parts supplied by a certain nerve, the cause of it is acting on the nerve-trunk or on its roots. If the cutaneous surface is involved, the lightest touch causes pain. If touching the skin produces no pain, but deep pressure does produce it, the deeper structures are the source. Pain in muscle and ligament is developed by motion: in muscle, by contraction, but not by passive movements with the muscle relaxed; in ligament pain is developed by active or passive movements. If, for example, a man with a stiff neck has pain on the right side of the back of his neck on voluntarily turning his face toward the left shoulder, but is without pain when his face is turned by the surgeon, who, conversely, induces pain by turning the patient's face far to the right, this condition indicates the trouble to be muscular. If, however, no pain arises on turning the face to the right, but it is manifest on turning the face actively or passively to the left, the pain is in those ligaments which stretch when the face is turned to the left (A. Pearce Gould).

The pain of colic differs from that of inflammation. It is sudden in onset, intermits and recurs in paroxysms, and is relieved by pressure. The pain of inflammation is gradual in onset, is continuous, and is made worse by pressure. The pain of neuralgia is very paroxysmal, comes suddenly, darts through recognized nerve-areas, lasts some hours, and is apt to recur at a certain hour. It presents no general tenderness, as does inflammation, but we may find several points which are acutely sensitive to pressure (Valleix's *points douloureux*).

Pain is of great value by calling attention to parts diseased, or is of great evil by racking the organism and even causing death. If pain continues, it becomes in itself formidable: it prevents sleep, it destroys appetite, and it disorders the mind, and one of the surgeon's highest duties is to relieve it. The expression of physical pain is one of heaviness, a fulness about the eyes and dropping of the angles of the mouth, added to appearances due to anæmia, tremor, etc.

Discoloration arises from determination of blood to the part; hence the more vascular the tissue the greater the discoloration. A non-vascular tissue presents no discoloration, though we find it adjacent in the zone of blood-vessels which bring the tissue nutriment. Discoloration is most intense at the focus or centre of inflammatory action. Discoloration varies in tint and in character according to the tissue implicated and to the nature of the inflammation, and it may be circumscribed or diffuse. Arborescent redness means a distribution in dendritic lines. Linear discoloration runs in straight lines, as in phlebitis. Punctiform discoloration occurs in points, and means vascular rupture. Maculiform redness means resembling an ecchymosis or blotch.

Inflammation of the throat and skin produces scarlet discoloration; inflammation of the sclerotic and fibrous coats of muscles produces lilac or bluish discoloration; inflammation of the iris produces brick-dust, grayish, or brown discoloration; erysipelas causes a yellowish-red discoloration; secondary syphilis causes a copper-hued discoloration; and tonsillitis causes a livid discoloration. A scrofulous ulcer is of a purple color on the edge. Gangrene is shown by a black discoloration.

Redness as a sign of inflammation must be permanent and joined with other symptoms. Redness due to inflammation disappears on pressure, but returns as soon as the pressure is removed. If redness is due to staining of the

surface, pigmentation, or extravasation, pressure will not blanch the spot. If on taking off pressure the redness of inflammation rapidly returns, the circulation is active; if, on the contrary, it very slowly reappears, the circulation is very sluggish and gangrene may occur.

Swelling or *tumefaction* arises in small part from vascular distention, but chiefly from effusion and cell-multiplication. The more loose cellular material a part contains, the more it swells; hence the eyelids, scrotum, vulva, tonsils, glottis, and conjunctiva swell very largely when inflamed. A swelling may be soft or œdematous, due to serous effusion, or it may be hard and elastic, due to embryonic tissue. Swelling may do good by unloading the vessels and acting like a blister or local bleeding, or it may do great harm by pressing upon the vessels and cutting off the blood-supply. Swelling of the conjunctiva, or chemosis, may cause sloughing of the cornea, and swelling of the prepuce can cause gangrene. A swelling may do harm by obstruction, as in œdema of the glottis, or by compression, as of the urethra, by the swelling of the perineum.

Disordered function is always present in inflammation. It may be manifested by *increased tenderness* or sensibility, a slight touch, it may be, producing torturing pain. Parts almost or entirely destitute of feeling when healthy (as tendons, ligaments, and bones) become highly sensitive when inflamed. In *increased irritability* in dysentery the colon constantly contracts and expels its contents; the stomach does likewise in gastritis; and the bladder also in cystitis. Spasmodic twitching of the eyelids occurs in conjunctivitis, and twitching of the muscles in fracture and after amputation.

Impairment of Special Function.—In inflammations of the eye objects cannot be looked at, the lids closing spasmodically; even a little light causes great pain and lachrymation (photophobia). In inflammations of the ear noises cause

great suffering, and even in quiet the patient has subjective buzzing and roaring sounds in his ears (tinnitus aurium). In coryza the sense of smell, and in glossitis the sense of taste, is lost; and in dermatitis the sense of touch, and in laryngitis the voice, may be lost. In inflammation of the brain the mind is lost; in arthritis the joints can scarcely if at all be used; and in myositis to employ the muscles is difficult and painful.

Derangement of Secretions.—In dermatitis the sweat is not thrown off; in hepatitis bile is not secreted; and in nephritis urine is not properly removed. The secretions may undergo important changes of composition. Pneumonia causes rusty sputum, and dysentery causes bloody mucus (Gross).

Derangement of Absorbents.—In the height of an inflammation the absorbents are blocked and clogged by coagulable lymph, and they cannot perform their offices.

Constitutional symptoms of inflammation may be absent, and often are in moderate or limited inflammations, but in severe extensive or infective inflammations we get the compound symptom *fever*. This is known as symptomatic, sympathetic, or inflammatory fever, and it arises in non-septic cases from the absorption of pyogenous exudate. In inflammation with fever the proportion of fibrin in the blood rises from 4 in 1000 to at least 8 in 1000. The fibrin ferment is contained in the white corpuscles; it is liberated as the corpuscles break up in the exudate, and, acting on the liquor sanguinis, forms fibrin. Inflammatory blood contains an increased amount of albumen and salts. If a person with inflammatory fever is bled, the blood coagulates rapidly, the clot sinks, and there is found on the surface a cup-shaped coat, made up of liquor sanguinis and white cells, known as the "buffy coat."

Treatment of Inflammation.—In treating an inflammation there must first be removed the exciting cause. If this

is from a splinter in the part, it must be taken out; if from a foreign body in the eye, it must be removed; if urine is extravasated, open and drain; take off pressure from a corn; and pull out an ingrown nail. After removing the cause, endeavor to bring about a cure by local and constitutional treatment.

Local Treatment of Inflammation.—It must be remembered that the division of inflammation into stages is natural, and not artificial, and that a remedy which does good in one stage may do harm in another. Certain agents are suited to all stages of an inflammation, namely, *rest* and *elevation*.

Rest is of infinite importance, and is always indicated in inflammation. Its principles were first thoroughly studied by Hilton.[1] The means of securing rest differ with the structure or the organ diseased, but when rest is used, do not employ it too long. In *cerebral concussion* rest must be secured by quiet, by darkness, by the avoidance of stimulants and meat, by the application of ice to the head, and by the use of purgatives to prevent reflex disturbance and the circulation of poisons in the blood. In *inflamed joints* rest must be obtained by proper position coupled with splints, plaster, or extension.

Muscular relaxation is a valuable form of rest. In *pleurisy* partial rest can be secured by strapping the affected side or by using a bandage or a binder to limit respiratory movements. In *fractures* Nature procures rest by a splint—the *callus*—and the surgeon procures rest by splints, immovable dressings, or extension. In fractures of the ribs, strap the chest on the injured side. In *cancer of the rectum* a colostomy secures rest for the damaged bowel. In *enteritis* opium gives rest to the bowel by stopping peristalsis. In *cystitis* rest is obtained by opium and belladonna, which paralyze the muscular fibres of the bladder. A cystotomy allows

[1] *Lectures upon Rest and Pain.*

complete rest by permitting the bladder to suspend its function as a reservoir of urine. In *vesical calculus* rest is obtained by cutting or crushing the stone. In *inflamed mucous membranes* rest is secured (from the contact of irritants) by touching them with silver nitrate, which forms a protective coat of coagulated albumen. Opening an *abscess* gives its walls rest from tension. In *inflammations of the eye* light should be excluded. In *aneurism* the operation cuts off the blood-current and gives rest. In *hernia* the operation gives rest from pressure. Instances of the methods of using rest could indefinitely be multiplied.

Elevation partly restores circulatory equilibrium. A *felon* is less painful when the hand is held up in a sling than when it is dependent. A *congestive headache* is worse during recumbency. A *gouty inflammation* in the great toe is more painful with the foot lowered than with it raised. A *toothache* becomes worse on lying down.

Relaxation is in reality a form of rest, and consists in placing the part in an easy position. In *synovitis* of the knee semiflexion of the knee-joint lessens the pain. In *muscular inflammations* relaxation relieves the pain.

Certain agents are suited to the stage of vascular engorgement, increased arterial tension, and beginning effusion. These agents are—(1) local bleeding or depletion; (2) cutting off the blood-supply; and (3) cold.

Local bleeding or *depletion* is the abstraction of blood from the inflamed area. This abstraction relieves circulatory retardation and causes the blood to move rapidly onward; the corpuscles clinging to the vessel-walls are washed away, the capillaries shrink to their natural size, and the exudate is absorbed. In other words, local blood-letting increases the rate of the circulation, though not its force.

The methods of bleeding locally are—(*a*) puncture; (*b*) scarification; (*c*) leeching; and (*d*) cupping.

Puncture is recommended in inflammation, not only because it abstracts blood locally, but also because it gives an exit to effusion under fibrous membranes. It is very useful in relieving tension, as in epididymitis. It is performed with a tenotome and with aseptic precautions. If punctures are made in numerous places, the procedure is termed "multiple puncture." This is very useful when applied to the inflamed area around a leg-ulcer.

Scarification or Incision.—By means of scarification we bleed locally, evacuate exudates, and relieve tension. We may make one cut or many cuts, which may be deep or may not even go entirely through the skin, according to circumstances. Multiple incision is applied to inflamed ulcers, ulcers in danger of gangrene, and almost any condition of great tension.

Leeching.—Leeches must not be applied to a region plentifully endowed with loose cellular tissue, as great swelling and discoloration are sure to ensue. These regions are the prepuce, labia majora, scrotum, and eyelids. Leeches should never be applied to the face (because of the scar), near specific scars or inflammations, nor over a superficial artery, a vein, or a nerve. A leech is best applied at the periphery of an inflammation or between an inflammation and the heart. To leech at the inflammatory focus only aggravates the case. Before applying leeches, wash the part and shave it if hairy. If the leeches will not bite, smear the part with milk or with a little blood. In using a leech, place it on the skin under a glass tube or an inverted wine-glass. Never pull off a leech: let it drop off; and if it refuses to do so, sprinkle it with salt. After removing a leech, employ warm fomentations if continued bleeding is desired. Sometimes the bleeding persists, but this may be arrested by styptic cotton and pressure. Leeching leaves permanent triangular scars. The Swedish leech, which is preferred to the Ameri-

can, draws from four to six drachms. Leeching has both a constitutional and a local effect. It is now used comparatively rarely, but it is of value over the spermatic cord in epididymitis, and on the temple in ocular inflammation. Occasionally the neck of the womb is leeched by holding the leech against it in a test-tube.

Cupping: Wet Cups.—In wet cupping, apply a cup for a moment, remove and incise or puncture, and apply it again to draw the requisite amount of blood. Baron Heurteloup devised an instrument (Fig. 18) in which the incision

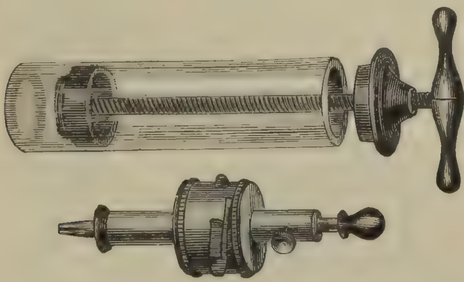


FIG. 18.—Heurteloup's Artificial Leech (Tiemann).

is made by a scarifier. The blood is drawn by a pump, the tube being placed upon the cut area and the withdrawal of the piston creating a vacuum. This instrument is known as the "artificial leech." Wet cupping is of value in pneumonia, pleurisy, pericarditis, and nephritis.

Cutting off the Blood-supply.—Onderdonk of New York in 1813 recommended ligation of the main artery of a limb for the cure of inflammation in important structures which it supplied. This procedure was warmly advocated by Campbell of Georgia for the treatment of gunshot wounds of joints. This plan of treatment is now not to be considered for a moment; antisepsis furnishes us with a safer and more

certain plan. Vanzetti of Padua advocates digital pressure to cut off the blood-supply to an inflamed part.

Cold is a very powerful and an extremely useful agent. It constringes the vessels, prevents migration of corpuscles, favors the absorption of exudate, retards cell-proliferation, and relieves pain, swelling, and tension. Cold must not be applied to the old or to the feeble, as it may induce gangrene. It is harmful in advanced inflammations or severe congestions (as strangulated hernia). There are two forms of cold, the dry and the wet.

Wet Cold.—To apply the wet cold, the part is wrapped in wet linen or muslin and laid upon a rubber sheet folded like a trough and emptying into a bucket. A

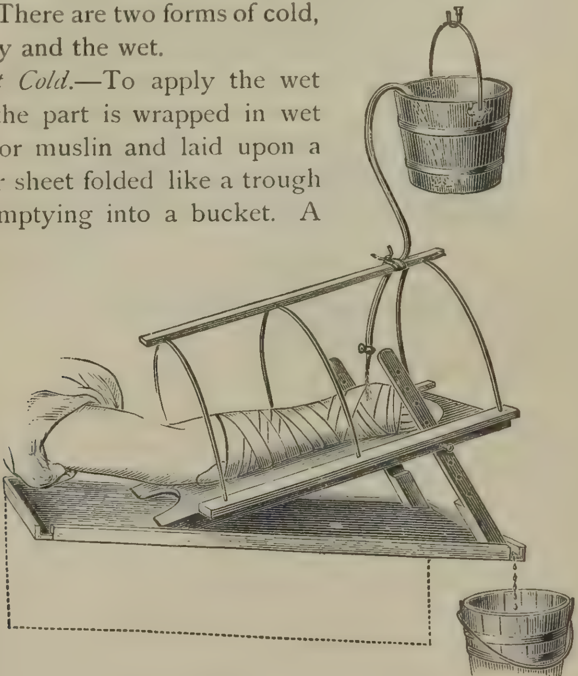


FIG. 19.—Siphon (Esmarch).

vessel filled with cold water is placed upon a higher level than the bed. A wet lamp-wick is now taken, one end is inserted into the water of the vessel, and the other end

is laid upon the part. Capillary action and gravity combine to keep the part moist (Fig. 19). Ordinary water or iced water can be used. If the water be too warm, it can be reduced to about 45° F. by adding 1 part of alcohol to every 4 parts of water. A mixture of 5 parts of nitrate of potash, 5 parts of chloride of ammonium, and 16 parts of water produces great cold. If we use wet cold upon an open wound, the fluid should be antiseptic. Wet cold is now not often used to irrigate. It is applied in severe conjunctivitis by means of cloths soaked in ice-water and frequently changed. Evaporating lotions owe a portion of their efficacy to the cold they induce.

Dry cold is applied by means of a rubber bag or a bladder filled with ground or finely-cracked ice, several folds of

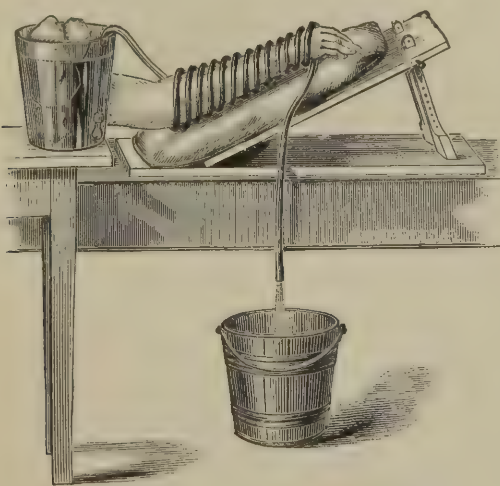


Fig. 20.—The Esmarch Cooling Coil (Esmarch).

flannel being first laid over the part. A part can be encircled with a rubber tube through which ice-water is made to flow (Fig. 20). Leiter's tubes, which are made to fit various

regions and which carry a stream of cold water, can also be used. An ice-bag, if applied at once, is the best treatment for a strained joint. Ice-bags are very useful in acute myelitis, meningitis, joint-inflammations, epididymitis, and other acute inflammations in the early stage.

Certain agents are suited to the stage of fully-developed inflammation, when we have a great deal of swelling due to effusion and cell-proliferation. The indication in this stage is to abate swelling by promoting absorption. This is accomplished by (1) compression; (2) the local use of astringents and sorbefacients; (3) the douche; (4) massage; and (5) intermittent heat.

Compression is the agent especially used in fully-developed and in chronic inflammation, but it will do good as well in the first stage. Compression is of great usefulness: it supports the vessels and causes them to drink up effusion, and strongly rouses the absorbents. This agent is valuable in most external inflammations with much swelling. In erysipelas of an extremity, besides the use of elevation and drugs, bandage the extremity from the periphery to the body. In ulcers, especially those with hard and blue edges, use the Martin elastic bandage or strap with plaster. In chronic inflammation of a joint elastic compression is of great value. In epididymitis, after the acute stage, strap the testicle with adhesive plaster. In lymphadenitis use compression by a weight or by a bandage. In fractures compression not only antagonizes spasm, but also combats the swelling and pain of inflammation. Compression must be judicious: it must never be too hard, and it must not be applied to a limb without including the extremity of it (never, for instance, strongly compress the elbow without including the hand, nor the palm without bandaging the fingers).

Astringents and Sorbefacients: Solutions of Acetate of Lead.—Ammonium chloride was formerly employed in the

strength of ℥j to 2 quarts of water, but if long used it produces pustules and thus causes irritation and pain. A solution of the acetate of lead is astringent and sorbefacient; it promotes the contraction of distended vessels, accelerates the blood-current, and urges the absorbents to increased activity. This agent, in practice, is usually mixed with laudanum, as follows: Laudanum, f℥j; liquor plumbi subacetatis, f℥j; aquæ, Oj. This solution, spoken of as lead-water and laudanum, is extensively used and is very soothing. It can be employed cold, the evaporation which it undergoes cooling the part. It is best applied by soaking a double layer of flannel in the lead-water, laying it on the affected part, and by means of a sponge squeezing more of the lotion upon it from time to time. If it is desired to have it very cold, an ice-bag can be placed upon the soaked flannel. Lead-water and laudanum may be used warm, the flannel being covered with oiled silk or waxed paper. If it is desired hot (veritably a poultice), lay upon the flannel a hot-water bag. Lead-water is not used in treating open wounds.

Tincture of iodine acts like lead acetate. It must not be used pure, but diluted for adults with an equal part of alcohol, and for children with 3 parts of alcohol. In using iodine, paint it on with a camel's-hair brush and fan it dry, applying one or more coats. The repeated application of iodine to the skin is of great benefit in inflammation of the glands, muscles, tendons, joints, and about ulcers and periosteal structures; it is apt, after a time, to vesicate, and must not be used in treating open wounds.

Nitrate of silver is a non-irritating astringent of great value in inflammation of mucous membranes. It forms a protective coat of coagulated albumen, and is much used in treating the throat, mouth, and genital organs.

Ichthyol is a drug of wonderful efficacy in reducing inflammatory swelling. It is usually employed in ointments

of a strength of from 25 to 50 per cent. It is best exhibited with lanolin. In acute rheumatism it can be rubbed upon the joints, and in lymphatic enlargements it is of great value. In children a 25 per cent., and in adults a 50 per cent., ointment is well rubbed in twice a day. In inflammatory skin disease, synovitis, thecitis, frost-bite, bubo, chilblain, and in many other conditions it is indicated. The odor of ichthyol is highly disagreeable, and when ordered for a refined person it had better be deodorized. For this purpose Hare uses oil of citronella, ♏xx to ℥j of ointment.

Mercurials.—Blue ointment, pure or diluted to various strengths, is valuable to a high degree. It is spread upon lint and kept applied over inflamed joints, glands, tendons, etc. Blue ointment is strongly irritant, and will soon blister or excoriate a tender skin. It is very beneficial in periostitis, and is employed largely in chronic inflammations.

The douche consists of a stream of water falling upon a part from a height. The water may be poured from a receptacle or may run through a tube, and may either be hot or be cold. Alternating hot and cold streams are very popular in chronic inflammations of joints and tendons, and they constitute the "Scotch douche." In a strain of the knee, for instance, where, after a time, thickening has occurred, pour upon the part daily, from a height, first a pitcherful of very hot water, then a pitcherful of very cold water; then use friction with a hand greased with cosmoline. The douche acts by restoring vascular tone and by promoting the action of the absorbents. Hot vaginal douches are largely employed in pelvic inflammations.

Intermittent heat finds an example in the use of very hot water in a strained and badly-swollen ankle by plunging the foot in a bucket of hot water several times a day.

Massage is a procedure not frequently enough employed. It is powerful for good in chronic inflammations at the

period where rest is abandoned. It acts by promoting the movements of tissue-fluids (blood, lymph, and areolar fluid), stimulating the absorbents, strengthening local nervous control, and thus improving nutrition. Passive motion in joints acts as massage.

Heat.—Certain agents are indicated when suppuration is threatened, these agents being the various forms of heat. Heat increases the mobility of the white corpuscles, increases their migration, relieves stasis and thus tension, promotes tissue-change and microbic action, and favors suppuration. Continuous heat may be used earlier in an inflammation, as in the first stage of a pneumonia, but it is so used only in a deep-seated trouble, and acts purely as a revulsive, dilating the superficial vessels and helping to empty the deeper ones.

The *forms of heat* are—(1) fomentations; (2) poultices; (3) water-bath; and (4) dry heat.

Fomentations.—A fomentation is the application of a liquid to the surface of the body on sponges or other material. To apply a fomentation, wring out a piece of flannel in hot water, lay it upon the part, and cover it with oiled silk or with waxed paper, changing it as soon as it begins to cool. The flannel which is dipped into the hot liquid is known as a "stupe." The turpentine stupe is made by wringing out the flannel as above and then putting upon it from 10 to 20 drops of turpentine. Instead of fomenting the part, steam may be thrown upon it. Fomentations are used chiefly for the reflex influence over deep congestions or inflammations. The liquid of a fomentation may, if desired, contain corrosive sublimate, carbolic acid, or other agents.

Poultice or Cataplasm.—A poultice is a soft mushy mass applied to a part to bring heat and moisture to bear upon it. Poultices are preferably made of ground flaxseed or of slippery-elm bark, but they can be made of arrowroot,

starch, bread and milk, potatoes, turnips, etc. To make a flaxseed poultice, scald a spoon and a tin basin, put the flaxseed into the dry hot basin, and pour upon it boiling water in sufficient quantity to form a thick paste. The proper consistence is found when the mass would stick to, if it were thrown against, a wall. It is now spread upon a piece of muslin to the thickness of a quarter of an inch, and covered with a bit of gauze or mosquito-net to prevent its adhesion to the skin. Flaxseed retains heat a long time, and it needs to be changed only every five or six hours. The poultice should be covered outside with oiled silk or with waxed paper. Spongiopiline is a good substitute poultice. Lint soaked with hot water and covered with some impermeable material does very well. The fermented poultice, which was once popular for gangrenous ulcers, was made by sprinkling yeast upon an ordinary cataplasm. The charcoal poultice is made by stirring charcoal into the usual poultice mass. A poultice containing opium is known as a "sedative." About gr. ij of opium to the ounce of poultice mass relieves pain. An antiseptic poultice is made by partly wringing out gauze in a hot solution of corrosive sublimate (1 : 1000), covering it with oiled silk, and placing a hot-water bag upon it to maintain the heat. Poultices must not be kept on too long, as they will then vesicate, especially in adynamic conditions. If a poultice is found to be vesicating, sprinkle it with powdered oxide of zinc. A wound should never be poulticed except by the antiseptic method.

Water-bath.—The continuous hot bath is now rarely employed except in cases of phagedæna, when it often proves curative. The water should in these cases contain bichloride of mercury.

Dry heat is applied by a metallic object dipped in hot water and laid upon the part; by Leiter's tubes, through which hot water flows; or by the hot-water bag.

Irritants and Counter-irritants in Inflammation.—Irritants cause an increased supply of blood to the part where they are applied; in other words, they are used for their local effects. *Counter-irritants* are used to affect by reflex influence some distant part. In chronic inflammation irritants may do good by promoting the blood-supply, thus favoring the removal of exudates (liniments in rheumatism and synovitis, and nitrate of silver in ulcers). Counter-irritants are powerful pain relievers when used over an inflamed part; they bring blood to the surface and cause anæmia of internal parts, the site and area of anæmia depending on the site, the area, and the duration of the surface irritation. To strongly counter-irritate too near an inflammation is harmful instead of beneficial. (Do not blister for pericarditis directly over the pericardium.—Brunton). Counter-irritants not only relieve pain and congestion in the earlier stages of inflammation, but they also promote absorption of exudate in the later stages. This is seen in blistering old thickened ulcers, and in painting the chest with iodine to relieve pleuritic effusion. Frictions, besides their pressure-effects, act as counter-irritants. Frictions may relieve skin-pain, and are associated with stimulating liniments in stiff joints.

There is no more efficient method of relieving pleural effusion than by a succession of blisters. They are used in inflamed joints, pericarditis, pneumonic consolidation of the lung, acute and chronic rheumatism, etc., and back of the ears or at the nape of the neck in congestive coma or meningitis. A blister can be obtained in a few minutes by soaking a bit of lint in chloroform, and, after applying it to the surface, covering it first with oiled silk, and then with a watch-glass. Equal parts of lard and ammonia will blister in five minutes. It is more usual to blister with cantharidal collodion or blistering-paper. Before applying a blister, shave the part if it be hairy; then apply the plaster, which

is left on six hours in the case of an adult, but only two hours in the case of an old person or a child; the plaster is then removed, and if a blister is not formed, the part must be poulticed for a few hours. When a blister is obtained, open it with a clean needle. If it be desired to heal the blister, grease it with cosmoline or with zinc ointment. If it is to remain open, dress it with from 4 to 6 drops of nitric acid to the ounce of cosmoline after cutting away the stratum corneum.

We can pustulate with tartar-emetic ointment, with the hot iron, or with Vienna paste. Tartar-emetic ointment was formerly used on the scalp in meningitis. To pustulate with the hot iron, use it at a white heat, lay it on the part, and, after using iced-water cloths for an hour or two, employ a poultice. The hot iron is the most powerful of counter-irritants, and is used for joint-inflammations, bone-diseases, and inflammations of the spinal cord. Vienna paste consists of 5 parts of caustic potash and 6 parts of lime made into a paste with alcohol. It is applied for five minutes, and is then washed off with vinegar.

Constitutional Treatment of Inflammation.—Certain remedies are used in inflammation for their general or constitutional effects; these remedies are—(1) general bleeding; (2) arterial sedatives; (3) cathartics; (4) diaphoretics; (5) diuretics; (6) anodynes; (7) antipyretics; (8) emetics; (9) mercury and iodides; (10) stimulants; and (11) tonics.

General bleeding, *venesection*, or *phlebotomy* is suited to the early stages of an acute inflammation in a young and robust man. The indication for its employment is increased arterial tension, as shown by a strong, full, rapid, and incompressible pulse in a vigorous young patient. General blood-letting diminishes blood-pressure and increases the speed of the blood-current, thus amending stasis, absorbing exudate, and washing adherent corpuscles from the vessel-wall; furthermore,

it reduces the whole amount of body-blood, thus forcing a greater rapidity of circulation, decreases the amount of fibrin and albumen, lowers the temperature, arrests cell-proliferation, and stops the effusion of lymph.

This procedure was in former days so highly esteemed that it settled into a routine formula to be applied to every condition from yellow fever to dislocation. The terrible mortality of the cholera epidemics from 1830 to 1835 led practitioners to question whether bleeding was or was not a general panacea, and from this doubt there was born in the next generation violent opposition to blood-letting in any disease. Like most reactions, opposition has gone too far, the pendulum of condemnation has swung beyond the line of truth and sense, and thus is universally neglected or broadly condemned one of the most powerful and valuable of resources. Many physicians of long experience have never seen a person bled; its performance is not demonstrated in most schools, and but few patients and families will permit it to be done. But when properly used it is invaluable. It is only applicable, however, to the young, strong, and robust, and not to the old, weak, or feeble. It is used in violent acute inflammations of important organs or tissues, and not for low inflammations or for slight affections of unimportant parts. It is used in the early, but not in the late, stages of an inflammation. It is used when the pulse is frequent, full, hard, and incompressible, but not when it is slow, small, soft, compressible, and irregular. It is used when the face is flushed, but not when it is pallid. It is not used in fat persons, drunkards, very nervous people, or the sufferers from adynamic, septic, or epidemic diseases. It is of infinite value in congestion of the lungs, pneumonia, pleurisy, meningitis, prostatitis, cystitis, and other acute inflammatory conditions.

Blood is usually taken from the median cephalic vein, the

incision being made with a bistoury, which is manageable, rather than with a complicated lancet, which is not. The median cephalic vein crosses the tendon of the biceps and goes to the outer side of the arm, the external cutaneous nerve lying just beneath it. The median basilic is larger, shows clearer, and is often selected for venesection. This vein goes to the inner side, and lies just superficial to the brachial artery, being separated from it by the bicipital fascia. The internal cutaneous nerve may lie over or under it. The median cephalic is harder and safer to bleed from, as we can only damage a cutaneous nerve; the median basilic is easier and more dangerous to bleed from, as we not only may damage a cutaneous nerve, but also the brachial artery (see *Phlebotomy*, p. 60).

The blood is allowed to flow into a basin, and the operator has his finger on the pulse to determine when to stop the flow. Bleeding is for effect, and not for quantity: the indication being a hard, incompressible pulse, the blood should be allowed to flow until the pulse is soft and compressible. This will often require from 10 to 20 ounces. Syncope may occur, and its onset is heralded by weakness, dimness of vision, nausea, vertigo, and sweating. When muscular weakness begins the fillet is untied, the patient is placed recumbent, the arm is washed with corrosive-sublimate solution, a compress of antiseptic gauze is put over the artery, a pad of gauze is laid over the compress, and a roller is run from the hand almost to the shoulder, the arm being hung in a sling. If the patient faints, he is placed with his head lower than the body; cold water is thrown in his face, mustard is put over the heart, and ammonia is passed under the nose. Caution must be observed in using ammonia, as it will cause spasm of the glottis if long held directly under the nostrils.

After bleeding the patient should be put upon arterial sedatives, diuretics, diaphoretics, anodynes, and, if necessary,

purgatives. A favorite mixture of Prof. S. D. Gross was the antimonial and saline, consisting of gr. xl of Epsom salts, gr. $\frac{1}{10}$ of tartar emetic, 3 drops of tincture of aconite, ʒj of sweet spirits of nitre, in enough ginger syrup and water to make ℥ss; given every four hours.

When a person has apoplectiform cerebral congestion, he should be bled, whether he is fat or thin; if thin, he should be bled from the arm; if fat, the arm-veins are indistinct, and he should be bled from the external jugular, cutting across, and not with, the fibres of the platysma myoides muscle.

Arterial sedatives are of great use before stasis is pronounced; if used after it exists, they will increase it. If stasis exists, relieve it by bleeding before using the sedatives. Venesection abolishes stasis and lowers tension, and arterial sedatives maintain the effect and hold the ground which is gained. The arterial sedatives employed are aconite, veratrum viride, gelsemium, and tartar emetic. These sedatives lessen the force and the frequency of the heart-beats, and thus slow and soften the pulse, and are suited to a robust person with an acute inflammation, but are not suited to a weak man in an adynamic state.

Aconite is given in small doses, never in large amounts. One drop of the tincture in a little water is given every half hour until its effect is manifest on the pulse, when it may be given every two or three hours. Large doses of aconite produce nausea and vomiting, and are dangerous. Aconite lowers the temperature, slows the pulse, and produces diaphoresis.

Veratrum viride is a powerful agent to slow the pulse and to lower blood-pressure; it produces moisture of the skin, and often nausea. It is given in 1-drop doses of the tincture every half hour until its physiological effects are manifested, when the period between doses is extended to two

or three hours. Ten drops of laudanum given a quarter of an hour before each dose of aconite or of veratrum viride will correct nausea.

Gelsemium is an arterial sedative highly approved by Bartholow. It is given in doses of 10 drops of the tincture every three or four hours.

Tartar emetic lowers arterial tension and lessens the pulse-rate. This drug is not largely employed; if it is used with the greatest care it is no better than some other agents, and if it is not so used it will cause dangerous depression. The dose is from gr. $\frac{1}{20}$ to gr. $\frac{1}{10}$ in water every three hours until the physiological effects are manifest.

Cathartics.—The tongue affords the chief indication for the use of cathartics. Treatment in an inflammation can be inaugurated, if constipation exists, by giving a cathartic. Castor oil can be given in capsules, or the juice of half a lemon can be squeezed into a tumbler, 4 ounces of oil poured in, and the rest of the lemon squeezed on top, thus making a not unpalatable mixture. Aloin, podophyllum, the salines, and calomel in 5- or 10-grain doses, followed by a saline, have their advocates. In peritonitis the salines are of unquestionable value, a teaspoonful of Epsom salt and a teaspoonful of Rochelle salt being given hourly until a movement occurs. In the course of the case, from time to time, if there be constipation, coated tongue, and foul breath, there should be ordered gr. j of calomel with gr. xxiv of bicarbonate of sodium, made into twelve powders, one being given every hour; if the bowels are not moved by the time the powders are all taken, a saline should be given. If a violent purgative effect is desired, as in meningitis, croton oil or elaterium may be ordered. If constipation is persistent, give fluid extract of cascara sagrada daily (15 to 30 drops), or a pill at night containing gr. $\frac{1}{4}$ of extract of belladonna, gr. $\frac{1}{4}$ of extract of nux vomica, gr. $\frac{1}{10}$ of aloïn, gr. $\frac{1}{4}$ of extract of

physostigma, and gr. ss of oil of cajuput. Enemas or clysters may be used in some cases. A very useful enema is composed of f℥j of oil of turpentine, f℥iss of olive oil, f℥ss of mucilage of acacia, in f℥x of water. Soap-suds and vinegar in equal parts make a serviceable clyster. A combination of oil of turpentine, castor oil, the yolk of an egg, and water can be used. Asafetida, gr. xxx to the yolk of one egg, makes a good enema to amend flatulence.

Diaphoretics are very useful. A good sweat in the start of a tonsillitis may abort the disease. Dover's powder is commonly used, but pilocarpine is preferred by some. Camphor in doses of from 5 to 10 grains is diaphoretic, and so are antimony and ipecac. Acetate and citrate of ammonium, opium, alcohol, hot drinks, heat to the surface (baths, hot bricks, hot-water bags), serpentaria, and guaiac are diaphoretic agents.

Diuretics are useful in fevers when the urine is scanty and high-colored, and are valuable aids in removing serous effusions and other exudates. Among the diuretics may be mentioned calomel in repeated doses, cocaine, caffeine, alcohol, digitalis, the nitrites, squill, turpentine, copaiba, and cantharides. The liquor potassæ and the acetate of potassium are the best agents to increase the solids in the urine. The liquor potassæ citratis in doses of gr. xxx is efficient. Large draughts of water wash out the kidneys. In weak heart the citrate of caffeine is a good stimulant diuretic.

Anodynes and hypnotics may be required. Dover's powder, besides being diaphoretic, is anodyne. Opium acts well after bleeding or purgation. If it causes nausea, it should be preceded one hour by gr. xxx of bromide of potassium. Opium is used by the mouth, by the rectum, or hypodermatically. It is used when there is pain, but its use is not to be long persisted in if it can be avoided. It is given in doses measured purely by the necessities of the case. If

opium disagrees, try the combination of morphia with atropine. After an operation antipyrine or phenacetine will often quiet pain and secure sleep. When a person feels "so tired he can't sleep," alcohol in the form of whiskey or brandy must be given. Sleeplessness not due to pain is met by chloral, the bromides, or sulphonal. Chloral is dangerous in conditions of weak heart or exhaustion. Bromides must be given in large doses. Sulphonal must be given about four or five hours before sleep is expected, in doses of from gr. x to gr. xv in hot milk.

Antipyretics, as exemplified in diaphoretics, purgatives, and arterial sedatives, have previously been alluded to (p. 63). There are two great classes of febrifuges—those which lessen heat-production and those which increase heat-elimination. In the first group we find quinine, salicylic acid and the salicylates, kairine, alcohol, antimony, aconite, digitalis, cupping, and bleeding. In the second group we find alcohol, nitrous ether, antipyrine, antifebrine, phenacetine, opium, ipecac, cold to the surface, and cold drinks. In surgical inflammations it is rarely necessary to employ heroic means to lower temperature. The use of such an agent as antipyrine is contraindicated in the weak and adynamic, and it is never to be thought of as a means of lowering temperature unless the latter goes above 103°. A good plan when compelled to use antipyretics is to start the reduction of temperature with antipyrine and to keep it down with gr. xx of quinine. Quinine, in doses of gr. xx to gr. xxx given at 4 P. M., may prevent an evening rise; salol or salicin can be given during the day. Inunctions of 30 minims of guaiacol lower the temperature in tubercular conditions and in septic fevers. These inunctions are made upon the abdomen, and often produce surprising results.

Emetics.—An emetic does good when there are a parched, coated tongue, a dry and hot skin, nausea, and gastric

oppression. There can be used ʒj of alum in molasses, gr. xx of sulphate of zinc, or a tablespoonful of mustard and a teaspoonful of salt given in warm water, followed by large draughts of warm water. Ipecac in a dose of gr. xx can be employed. The emetic dose of tartar emetic is gr. ij, but it is too depressant. The sulphuret of antimony in doses of from 1 to 5 grains is safe. Apomorphia hypodermatically, in a dose of from gr. $\frac{1}{16}$ to gr. $\frac{1}{8}$, will act in five minutes. Emetics are valuable in inflammatory conditions of the air-passages. Emetics are contraindicated in diseases of the heart, brain, and bowels, in hernia, in dislocations, in fractures, and in aneurysms.

Mercury and the Iodides.—Mercury is an alterative—that is, an agent which favorably affects body-nutrition without causing any recognizable change in the fluids or the solids of the body. Mercury lessens blood-plasticity, hinders the exudation of liquor sanguinis—thus furnishing less food to the cells in the perivascular tissues—and retards the formation of embryonic tissue. Further, by a stimulant action on the absorbents it promotes the breaking up of an existing inflammatory exudate, and hence limits damage from excess of embryonic tissue. The time at which mercury is best given is when violent symptoms have abated, the guide being reduced temperature and moist skin. It is often given in conjunction with sorbefacients (as the acetate of lead), and is, when possible, associated with compression. It is usually given until the gums are slightly touched, but is not often given to salivation. When the breath becomes offensive and the gums tender on snapping the teeth, the dose should be reduced. In iritis mercury is used to get rid of the plastic effusion which is causing pupillary fixation and opacity. In keratitis the gums should be touched lightly. In orchitis, after the subsidence of the acute symptoms, mercury should be employed. In pericarditis, menin-

gitis, peritonitis, and in many chronic and lingering, and in all syphilitic, inflammations this drug may be used.

Some persons will be salivated with very minute doses of mercury, either from idiosyncrasy or previous saturation. Others can take enormous doses without any appreciable constitutional effect, but its action can be favored by a combination with ipecac or with tartar emetic.

Salivation, *ptyalism*, or *mercurial stomatitis* is made manifest by the excessive flow of saliva; white patches over the buccal surface; purple, tender, spongy, ulcerating gums; foul breath; gray-coated tongue; tenderness, loosening, and later dropping out, of the teeth; enormous swelling of the tongue, jaws, face, the salivary and lymphatic glands; and great interference with audition, respiration, articulation, and deglutition. Gangrene may occur. Salivation is to be treated by astringent gargles, atropine, chlorate of potassium internally and locally, anodynes, and iodide of potassium. If suffocation is impending, scarify the tongue. A very useful mouth-wash is prepared as follows:

℞. Acid. boracic.,	℈ij;
Listerine,	℥iv;
Aquæ,	q. s. ad f℥viij.—M.
Sig. Locally p. r. n.	

A favorite prescription with the late Professor Gross consisted of ʒj of liquor plumbi subacetatis (Goulard's extract) to ℥viij of water, used as a mouth-wash every hour. The dental discoloration produced by Goulard's extract will after a time pass away. A very useful gargle consists of gr. xlviij of chlorate of potash, ʒss of tincture of myrrh, and sufficient elixir of calisaya to make f℥iij. This can be given in ʒj doses every three or four hours, or be used as a mouth-wash.

The usual plan of treatment for salivation is to stop the mercury; place on a bland diet; if the swelling or pain interferes with feeding, push into the pharynx through the

nose a tube, and feed through it; after taking food clean out thoroughly and swab the mouth every two or three hours with a cotton pledget saturated with peroxide of hydrogen, and follow this by the use of one of the above-named mouth-washes. A hot bath should be ordered once a day, or a Turkish bath every third day. Give 10 grains of iodide of potassium three times a day, and gr. $\frac{1}{100}$ of atropine at night. Sleep is secured by opiates if the pain is severe. Stimulants are indicated for exhaustion. When convalescence begins there should be ordered open-air exercise, nourishing food, red wines or malt liquors, and tonics. A mild case of salivation can be arrested in two or three days; a severe case is of uncertain duration, and may prove fatal.

In giving mercury, if a prompt effect is desired, give gr. iij of calomel every three hours until a metallic taste is noted in the mouth. If the case is not so urgent, gray powder is a good combination. If it is desired to give the drug for some time, corrosive sublimate is a suitable form, and small doses will actually increase the number of red blood-corpuscles. Corrosive sublimate is to be given alone or combined only with iodide of potassium. In the prolonged use of mercury it will often be necessary to give at the same time a little opium to prevent diarrhœa and griping. A rapid effect can be obtained by rubbing with a gloved hand ʒj of the oleate of mercury or ʒss of the ointment into the groin, the axillæ, or the inside of the thighs. Suppositories of mercurial ointment induce rapid ptyalism. Hypodermic injections of corrosive sublimate can be used, and must be thrown deeply into the muscles of the buttock. Old people, those who are exhausted, anæmic, and broken down, and the scrofulous, bear mercury badly. If it be given at all, it must only be given to them in small amounts and for a brief time.

Alkaline iodides, which are useful in removing the products of inflammation, can be given for a long time, and

they admirably supplement mercurials. Iodide of potassium can be prescribed in combination with corrosive sublimate, as follows:

℞.	Hydrarg. chlor. corros.,	gr. ij;
	Potass. iodidi,	ʒv et ℈j;
	Syr. sarsaparillæ comp.,	q. s. ad f℥viij.—M.

Sig. fʒij, in water, after meals.

Iodide, well diluted, is given on a full stomach; it is never given concentrated nor before meals. A convenient mode of administration is to procure a concentrated solution of the iodide of potassium, remembering that every drop equals gr. j of the drug, and give as many drops as desired in half a glass of water after meals. If this disagrees, add to each dose, after it is put in water, ʒj of the aromatic spirits of ammonia. Extract of licorice is a good vehicle for iodide. If the mixture in water disagrees, it should be tried in milk. Capsules are satisfactory, but a drink of water should be taken just before and again just after taking a capsule, to protect the stomach from the concentrated drug. Iodide of sodium may agree when iodide of potassium does not. When the iodides disagree they produce iodism. The first indications of iodism are a bad taste in the mouth, running of the eyes and nose, and sneezing, followed by a feeling of exhaustion, absolute loss of appetite, nausea, tremor, and skin-eruptions (acne, hemorrhages, blebs, hydroa, etc.) If iodism occurs, stop the drug and give the patient Fowler's solution in increasing doses, laxatives, diuretic waters, and also good food and stimulants if depression is great. Sometimes belladonna does good in obstinate cutaneous disorders.

Alcoholic stimulants are used for conditions, and not for diseases, their use being indicated by the state of the patient, rather than by the name of the malady. For a brief acute inflammation in a robust young person alcohol is not needed; but all who are weak or exhausted—the young,

the old, those accustomed to alcoholic beverages, those who have high temperatures or failure of circulation, and those who labor under septic inflammations or adynamic processes—require alcohol to be given with a free hand. Certain indications for alcohol in an acute malady are a feeble, compressible, rapid, and often irregular pulse and great weakness of the first sound of the heart. Low muttering delirium is a strong indication. There is no *dose* of alcohol in these states: it is given for its effect. Two ounces may be needed in a day, or perhaps twenty ounces. If the breath of the patient smells strongly of the alcohol, he is getting too much. If delirium increases after each dose, it is doing harm. Alcohol is contraindicated in acute meningitis. In acute illness use whiskey, brandy, champagne, or alcohol and water. During convalescence there may be used a little spirit—port, claret, or sherry wine or malt liquor. These agents will promote appetite, digestion, and sleep.

Tonics are indicated during convalescence from acute and throughout the course of chronic inflammations. There may be used iron, quinine, and strychnine in the form of elixir; iron alone, as in the tincture of the chloride; quinine in tonic doses (gr. vj to gr. viij daily); or Fowler's solution of arsenic. An excellent pill consists of—

℞. Acid. arsenos.,	gr. j;
Strychnini,	gr. ss;
Quinine,	gr. xlviij;
Ferri redact.,	gr. vj.
Ft. in pil. No. xxiv.	
Sig. One after each meal.	

Bitter tonics before meals improve the appetite. One of the best of these tonics is tincture of nux vomica.

Antiphlogistic regimen includes all the facts relating to diet, ventilation, cleanliness, etc.

Diet.—When, in the early stages of an acute inflammation,

the patient cannot eat, there must be administered a cathartic before food is given. Nausea is combated with calomel and soda, drop-doses of a 6 per cent. solution of cocaine, iced champagne, or cracked ice. When the process is depressive from the start, and in any case after the earliest stage, feeding is of vital moment. The great tissue-waste calls for much food, but the impaired digestion demands that it shall easily be assimilable; hence it is taken in liquid form, small quantities being frequently given. Milk contains all the elements required by the body, and is the food of foods. If it disagrees, it should be boiled and mixed with lime-water, or to each dose an equal amount of Vichy or soda-water may be added. Peptonized milk is a valuable agent. One part of milk, 2 parts of cream, and 2 parts of lime-water make a nutritious and digestible mixture. Milk punch is largely used. Whey may be used when milk cannot be taken. Eggs are highly nutritious, but are apt to disturb the stomach; they may be given as egg-nog, or simply soft-boiled, or the yolk can be beaten up in a cup of tea. When considerable nausea exists the yolk of an egg may be added to ℥j of lemon-juice and ʒij of sugar, the glass being filled with carbonated water. Beef tea is certainly a stimulant, but its food-powers are questionable. It is prepared by cutting up one pound of lean beef, adding to it a quart of water, and then simmering, but not boiling, down to a pint, and finally by filtering and skimming the liquid. The dose is a wineglassful seasoned to taste. Meat-juice, made by squeezing out partly-cooked meat with a lemon-squeezer, is also highly nutritious. Liquid-beef peptonoids are both agreeable and nutritious; they are given in doses of ℥ss to ℥j. When nothing else will stay on the stomach koumiss will often be retained. This fermented milk is nutritious, stimulant, and very useful. Coffee is a valuable stimulant in febrile conditions. When the sufferer feels able to eat a little, any good

soup, strained and skimmed, should be ordered. As the patient gets better he may be fed on sweetbreads, chops, etc. until he gradually reaches the ordinary diet; if his stomach rejects everything, he must be fed by the rectum.

Ventilation and Cleanliness.—The ventilation of the apartment is of the greatest importance. Every day the windows should be opened widely for a time, the patient of course being protected. A constant access of fresh air must be secured, and the temperature kept at about 68°. The sick man must be cleaned and be sponged off with alcohol and water every day if high fever exists. It is important that the bed-clothing be clean and that the sheet be unwrinkled, as otherwise bed-sores may form.

III. REPAIR.

Repair is an active process by which destroyed tissues are replaced, and it is due to increased nutritive activity, rather than to inflammation. Inflammation may occur, or we may be obliged to induce it when the blood-supply is scanty or the exudation deficient; but certain it is that an aseptic wound heals without many of the evidences of inflammation.

Healing by First Intention.—A wound may heal by "first intention." This mode of healing, which is known as "primary union," occurs without suppuration. If pus forms, primary union will not take place. When the edges of an incised wound are brought nicely in apposition, after stopping the hemorrhage and asepticizing thoroughly, slight swelling comes on, but no discoloration. Lymph and leucocytes are exuded from the vessels, fibrin forms in this lymph, and the edges of the wound are stuck together by a natural cement. In extensive wounds the exudation is in excess, and much of it must be drained away, for its retention means tension, inflammation, and a warm nest for pus cocci. The exudation is con-

verted into embryonic tissue by multiplication of its own cells and multiplication of tissue-cells. Embryonic or granulation-tissue consists of small round or oval cells held together by a jelly-like intercellular substance. In a few days some spindle-shaped cells can be found, and also large cells with one or more nuclei (epithelioid cells). Prolongations of embryonic tissue are raised up by capillary loops, which prolongations fuse with one another end to end, or they fuse with other capillary loops, and are hollowed out and become endothelial tubes or capillaries. After vascularization or organization the embryonic tissue becomes fibrous (Figs. 21, 22). The final step in healing is the cover-

FIG. 21.—Nuclei developing into Fibres (Bennett).

FIG. 22.—Cells developing into Fibres (Bennett).

ing of the surface with epithelium, the cells springing from the epithelial cells upon the edges. This final process is called "cicatrization," and consists in the contraction of the wound and its skinning over. The "immediate union" of some writers never occurs. It means the union of microscopical parts to their counterparts without any effort at repair. A first union is effected always by fibrin, and next by embryonic tissue.

Healing by Second Intention.—In a wound whose edges cannot be approximated a great gap has to be filled, which is accomplished by granulation. This process is known as "heal-

ing by granulation" or "second intention." In an hour or so after the infliction of such a wound (it may be in less time) the raw surface is covered with a thin glazed layer of coagulated exudate. This glaze is fibrin, which soon becomes filled with leucocytes; underneath this fibrin-coat proliferation is proceeding and embryonic tissue is forming. The wound-discharge is at first thin and red, but in a few days becomes purulent and so profuse as to wash away the discolored fibrin-coat. Granulations are now disclosed, the embryonic tissue being lifted up in countless points by capillary loops. When these loops approach the surface contraction begins, which brings the edges of the wound nearer together and gradually cuts off the excessive blood-supply which is no longer needed. When the granulations reach the surface, epithelium in a thin bluish film grows from the epithelial cells at the edge and covers the ulcer. Cicatrization is contraction plus skinning over with epithelium. Epithelium can only spring from the wound-edges, unless there be some epithelial structural remains in the wound, such as an undestroyed papilla, a sweat-duct, or a hair-follicle. If the granulations rise above the surface, constituting exuberant granulations or proud flesh, they must be cut off or burned away before epithelium will grow over the wound. Pale œdematous granulations are usual in tuberculous processes. The contraction of cicatrization results from the conversion of embryonic tissue into fibrous tissue (Figs. 21, 22). Contraction is so great after some wounds as to cause terrible deformities. This is notably the case after burns whose scars or cicatrices contain much elastic tissue. Coagulation necrosis of a superficial layer of granulation-tissue produces a diphtheritic membrane or aplastic lymph. This coagulation necrosis depends on capillary closure or lack of capillary development, the embryonic tissue dying for want of nutriment.

Healing by Third Intention.—This consists in the union

of two granulating surfaces, as the union of collapsed abscess-walls. In subcutaneous wounds, if aseptic, healing occurs without suppuration. First a blood-clot fills the wound, exudate occurs, and embryonic tissue forms in the walls of the cavity; the new granulation-tissue grows into the clot, which is broken up and absorbed, and organization and contraction of the embryonic tissue take place. If suppuration occurs, an abscess forms. Healing under an aseptic blood-clot is healing "by first intention." The fibrous tissue of a scar arises from connective tissue, which itself arose from embryonic tissue. The multiplication of connective-tissue cells may be by direct, but it is usually by indirect, division.

Cell-Division.—*Direct cell-division* consists in division of the nucleus followed by division of the entire cell.

Indirect cell-division, or *karyokinesis*, shows remarkable changes in the nucleus. The membrane of the nucleus disappears; the nuclear network becomes first close and then more open, and the cells become round, if not so before. The network of the nucleus, now consisting of one long fibre, takes the shape of a rosette; next it takes a star-form—the aster stage; two sets of V's next form—the equatorial stage; an equatorial line appears and widens, and each set of V's retreats toward a pole. Thus two new nuclei are formed, each polar V passing in inverse order through the previous changes of shape, and the protoplasm of the original cell collects about each nucleus (Fig. 23).

In non-vascular tissues, such as cornea or cartilage, the wound is glued together by fibrin, the exudate having come along the lymph-spaces from adjacent vascular areas. Organization occurs by multiplication of fixed tissue-cells and leucocytes. Divided muscle unites by fibrous tissue. Divided nerve, when approximated, can regenerate. Tendon unites by fibrous tissue which after a time becomes truly tendinous. Bone first unites by embryonic tissue which becomes fibrous

and bony. When an artery is ligated, embryonic tissue forms in and around it, the walls soften and are converted into the same tissue, and the artery is organized into a fibrous cord.

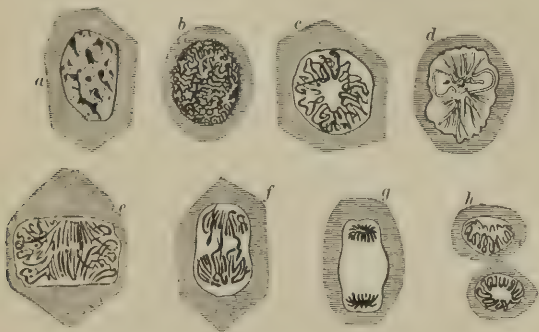


FIG. 23.—Forms Assumed by a Nucleus Dividing (Green, from Flemming).

An ulcer heals in the same manner as does a wound—by second intention. An abscess heals by collapse of its sides and their adhesion. The sides are embryonic tissue which is formed into granulations, these granulations unite, and organization into fibrous tissue takes place.

IV. SURGICAL FEVERS.

The surgeon encounters fever as a result of an inflammation or an aseptic wound, in consequence of infection, and in certain maladies of the nervous system. It is important to remember that, while elevated temperature is generally taken as a gauge of the intensity of fever, it is not a certain index. There may be fever with subnormal temperature (as in the collapse of typhoid or pneumonia), and there may be elevated temperature without true fever (as in certain brain diseases). It is true, however, that elevation of temperature is almost always noted.

The essential phenomena of fever, according to Maclagan, are—(1) wasting of nitrogenous tissue; (2) increased consumption of water; (3) increased elimination of urea; (4) increased rapidity of circulation; and (5) preternatural heat.

Types of Fever.—Fevers, whatever their causation and special names, belong to one of three fundamental types, just as the diverse varieties of men belong to certain fundamental races. These three types are—(1) sthenic fever; (2) asthenic fever; and (3) nervous fever.

Sthenic Fever.—The sthenic or inflammatory type, found in the young and robust as a result of acute inflammation, is characterized by violent action at an early period. It is ushered in by malaise, chilly sensations or a moderate chill, want of appetite, nausea and often vomiting, and pain in the back and limbs. The pulse shows increased pressure, is frequent, full, hard, and incompressible (runs from 90 to 120); the face is flushed; the eyes are suffused and intolerant of light; the skin is dry; the respiration is accelerated; the mouth is dry, and the tongue is coated. There is thirst, anorexia, often nausea and bilious vomiting, and constipation; headache; an insufficient amount of sleep, and disturbing dreams when the patient sleeps; he may show a delirium of an agreeable character. There is aching and soreness in the back and limbs, and emaciation. The temperature, which attains its height in from two to four days, rarely exceeds 103°. The urine is scanty, high-colored, offensive, and often contains albumin and casts. A fever may be sthenic in the beginning, but become asthenic later in the attack. The genuine sthenic type terminates by lysis. An acute pleuritis in a robust subject affords an example of the sthenic type of fever.

Asthenic Fever.—The asthenic typhoid or adynamic type occurs in the weak, the sickly, the debilitated, and in those at the extremes of life. It is the fever of pyæmia, sep-

ticæmia, diphtheria, typhoid, etc., and it is often ushered in by a chill or chills and profound depression. The pulse is soft, tremulous, weak, compressible, frequent, and quick (110 to 160). The temperature is elevated (100° to 108°), often for long periods, and oscillates greatly. Chills may recur; the respirations are rapid and shallow; the skin is cold, clammy, often drenched with cold sweat; the face is lividly pale; the eyes sunken and partly closed; the tongue is dry, hard, and covered with a brown fur; sordes gather on the gums and teeth; the muscles and tendons twitch (*subsultus tendinum*); the patient picks at the bed-covers in a bad case (*carphalogia*); the appetite is absent, and the powers of assimilation at a low ebb; there are hiccough, great wasting, and diarrhœa; the urine is scanty, high-colored, often albuminous; the mental condition is one of torpor, apathy, or stupor, with low muttering delirium. Bad subsultus, persistent vomiting, carphalogia, or continued hiccough and a "Hippocratic" countenance usually indicate death, which is apt to happen in coma. The Hippocratic countenance presents the following elements: "A sharp nose, hollow eyes, collapsed temples; the ears are cold, contracted, and their lobes turned out; the skin about the forehead is rough, distended, and parched, the color of the whole face being brown, black, livid, or lead colored."

Nervous Fever.—The irritative or nervous type is apt to attend the adynamic type, and is often met with following carbuncles, sloughing, and late eruptions of pox. The temperature is irregularly elevated (101° to 103°). There are nervous chills, but not rigors. The mind is fretful, peevish, anxious, and despondent; pain is magnified; the pulse is quick, small, jerking, and often irregular; the skin is hot and dry; severe headache and pain in the back and limbs are complained of; insomnia is distressing, and the sleep obtained is disturbed by vivid dreams; restlessness is pro-

nounced, and loud noises or bright lights produce much annoyance.

Traumatic fevers follow a traumatism and attend the healing of a wound. The forms are—(1) primary wound-fever; and (2) secondary wound-fever.

Primary wound-fever is a result of the changes going on in a wound which does not contain pus. It is divided into two forms: (*a*) aseptic fever; and (*b*) traumatic or surgical fever.

Aseptic fever appears after a thoroughly aseptic operation and after a simple fracture or a contusion. It may appear during the evening of the operation or not until the next day, and reaches its highest point by the evening of the second day (100° to 102°). This elevation is spoken of as the "post-operation rise." Besides the fever there are no obvious symptoms; the patient feels first-rate, and often wants to sit up; there are no rigors and there is no delirium. This fever is due to absorption of pyrogenous material from the wound-area, where clot-tissue and exudate may be absorbed. The pyrogenous element seems to be fibrin-ferment. In some cases an aseptic fever may appear after an operation, and later be replaced by a septic fever. If the temperature remains high after a few days or if other symptoms appear, the wound should be examined at once, as trouble certainly exists.

Traumatic or *surgical fever* is seen in the healing of infected wounds where there is inflammation, but no pus. This fever is due to the presence of bacteria in the wound and the absorption of their ptomaïnes. It ceases as soon as free discharge occurs, and its appearance is an indication for instant drainage. The temperature rises pretty sharply in a day or so after the operation, ascends with evening exacerbations and morning remissions, and reaches its height about the third or fourth day, when suppuration sets in; the tem-

perature begins to drop if the pus has free exit, and reaches normal at the end of a week (see *Suppurative Fever*). When the fever begins the wound should be inspected, the stitches removed where stitch-abscesses exist, and the area drained and asepticized. The fact that this fever is apt to cease when suppuration begins led the older surgeons to hope for pus and to endeavor to cause it to form.

Secondary Wound-fever: Suppurative Fever.—This fever, which is due to the absorption of the ptomaïnes of pyogenic cocci, occurs after suppuration has begun, and is found when the pus has not free exit. If the post-operation rise continues, or if, after it has gone, a secondary rise occurs, look out for pus. Suppuration in a wound is indicated by a rapid rise of temperature—possibly first by a chill. The wound must at once be drained. In a chronic suppuration, such as occurs in a tubercular process, there exists a fever with marked morning remissions and vesperal exacerbations, attended with night-sweats, emaciation, diarrhœa, and exhaustion. This is known as "hectic fever;" it is really a chronic suppurative fever. The treatment of hectic fever consists in draining or, if possible, excising the infected area, a nutritious diet, open air, stimulants, tonics, and in giving remedies for the exhausting sweats.

V. TERMINATIONS OF INFLAMMATION.

Inflammation can terminate in—(1) effusion of serum; (2) effusion of lymph; (3) formation of pus; (4) ulceration; and (5) mortification.

Effusion of Serum.—The so-called "serum" of inflammation is not serum at all, but is liquor sanguinis. We meet with true serum in passive congestions, but not in active hyperæmias. Effusion of serum into connective tissue constitutes œdema; and into a sac, like the peritoneum, dropsy;

dropsy being designated by the prefix *hydro-*, as hydrothorax. Abdominal dropsy is ascites. Anasarca is general effusion of serum resulting from altered blood-pressure. Œdema is made manifest by the signs of inflammation, the swelling being soft, smooth, and inelastic, and the parts pitting on pressure. Effusion of serum may be beneficial, unloading the vessels and hence relieving pain, tension, and hyperæmia. It can do harm. In connective tissue it may exist in such quantity as to cut off the circulation of certain areas, thus causing necrosis. Effusion into a cavity causes pressure on its contained parts; for instance, in a hydrothorax the lung is compressed.

Treatment.—Œdema can be relieved by multiple punctures, but if it threatens necrosis free incisions must be made. If the dropsy be considerable, the fluid must be let out by tapping, aspiration, or incision. Tapping must be done aseptically, but it offers danger of infection, as air is bound to enter and be retained. In aspirating use full aseptic care. When it is wished to drain the abdomen, the latter should always be opened with a knife, because an intestine might happen to be glued to the abdominal wall; hence if a trocar or a needle were used perforation would take place. In a moderate œdema there is used locally compression, and tincture of iodine diluted with an equal bulk of alcohol. In persistent œdema employ frictions with a stimulating liniment. Internally, salines and diuretics are indicated. The compound jalap powder is well suited to dropsies. Mercurials can be used, and in severe cases also elaterium.

Effusion of Lymph.—The term "lymph" is a synonym for fibrinous exudate, coagulable lymph, plastic infiltrate, solid inflammatory new formation, organized new formation, indifferent tissue, granulation-tissue, or embryonic tissue. Here we have effusion of highly albuminous liquor sanguinis, with proliferation of the blood-corpuscles and the

fixed connective-tissue cells (Fig. 24). Effusion of lymph means a more severe inflammation than does the effusion of serum. Lymph may be absorbed or it may be organized into tissue. If it becomes organized, capillaries form in it

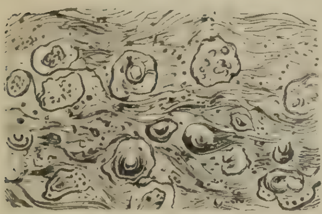


FIG. 24.—Recent Lymph, forming False Membrane (Gross).

FIG. 25.—Blood-vessels in Granulation (Gross).

by the extension from the surrounding tissue of capillary loops, which raise up the lymph and form granulations. A granulation may be defined as a small mass of lymph containing vessels (Fig. 25).

Lymph is divided into two forms—*plastic* or *formative* lymph, that which can be converted into tissue, hence that which brings about repair; *aplastic* or *croupous* lymph, that which develops no fibres and cannot be converted into tissue, and which in consequence cannot bring about repair. Effusion of lymph may be beneficial. It repairs all injuries; it surrounds and encapsules foreign bodies; it circumscribes abscesses; and it often prevents pus from evacuating into a cavity, gluing together structures to make a channel and leading the pus to the surface. It may be injurious. It forms adhesions of the brain, pleura, peritoneum, pericardium, and joints; it produces opacity in the cornea and adhesions of the iris; it constitutes the false membrane of the larynx or trachea; and it causes stricture of the urethra and thickening of organs.

Treatment.—Locally, employ compression, tincture of

iodine, lead-water and laudanum, alternating hot and cold douches, friction, and massage; also ichthyol and lanolin. Internally, use mercurials and iodide of potassium or tartar emetic. Prof. S. W. Gross recommended the following mixture for inflammatory thickening:

℞. Potassii iodidi,	gr. x;
Hydrarg. chloridum corros.,	gr. $\frac{1}{16}$;
Antimonii et potassii tartras,	gr. $\frac{1}{16}$.—M.

Sig. Three times a day, in half a glass of water, after meals.

Suppuration is a process in which tissues and inflammatory exudates are liquefied by the action of pyogenic cocci, and it is a common termination of infective inflammation. Localized suppurations are due to staphylococci; spreading suppurations, to streptococci. Cocci liquefy exudates and tissues by peptonizing them. Suppuration can be induced by the injection of cocci, by their entry through a wound, and by rubbing them upon the skin. In some rare instances, especially when the diet has been putrid, they may enter through the blood. The entry of cocci does not necessarily mean suppuration, as the healthy human body can destroy a moderate dose, but a large dose in a healthy, or even a small dose in an unhealthy, organism almost certainly does. The pus of all acute abscesses contains cocci, but the pus of tubercular abscesses does not, unless there be a mixed infection; in other words, pure tubercular pus is not pus at all.

Can suppuration be induced without micro-organisms? It is true that the injection of irritants can cause the formation of a thin fluid which contains no organisms, but this non-bacterial pus is not pus. The same sort of fluid is formed by injecting cultures of cocci which have been rendered sterile by heat, the organisms being killed, their products being the active agent. Spurious or "aseptic" pus does not concern us, as it is never found practically. Impaired health or an area of lowered vitality predisposes to suppuration.

The lymphatic glands, medulla of bones, serous membranes, and connective tissue are especially prone to suppurate. When a medullary canal suppurates as a result of a blow that does not cause a wound, we know that the organisms must have arrived by means of the blood.

Pus may form in twenty-four hours after an inflammation begins, or it may not form for days. The older surgeons claimed that pus could do good by protecting granulations and separating disorganized tissue. It is now held that it is absolutely harmful by melting down sound tissue and poisoning the entire organism. Modern surgery has to a great degree abolished pus.

If pus stands for a time, it separates into two portions—(1) a watery portion, the liquor puris or pus-serum, containing peptone, fat, microbic products, osmazone, and salts, and not tending to coagulate; (2) a solid portion, or sediment of pus cocci, pus-corpuscles (Fig. 26), and broken-down tissue. The pus-corpuscles are either white blood-cells or the fixed cells of connective tissue. Some of them are dead, some have amœboid movements, some are fatty, others are granular and contain more than one nucleus, and all are degenerating. A pus-cell is waste matter, and it cannot aid in repair.

Forms of Pus.—*Laudable* or *healthy pus*, a name long in vogue, is a contradiction, no pus being healthy. In former days free suppuration after an operation was regarded as a favorable indication, showing that there was no septicæmia, which disease dries up wound-discharges. At the present day suppuration after an operation is an evidence of previous infection, of unpardonable lack of care, or of infection by the blood. This form of pus is seen coming from a healing ulcer, and is a yellowish-white or a greenish fluid of the consistence of cream, opaque, with a very slight odor if it is not putrid, and has a specific gravity of about 1.030.

Malignant, *watery*, or *ichorous pus* is a thin, watery, putrid

fluid. It is pus rendered putrid by the organisms of putrefaction (bacterium termo).

Sanious pus is a form of ichorous pus containing blood coloring-matter or blood. It is thin, of a reddish color, and

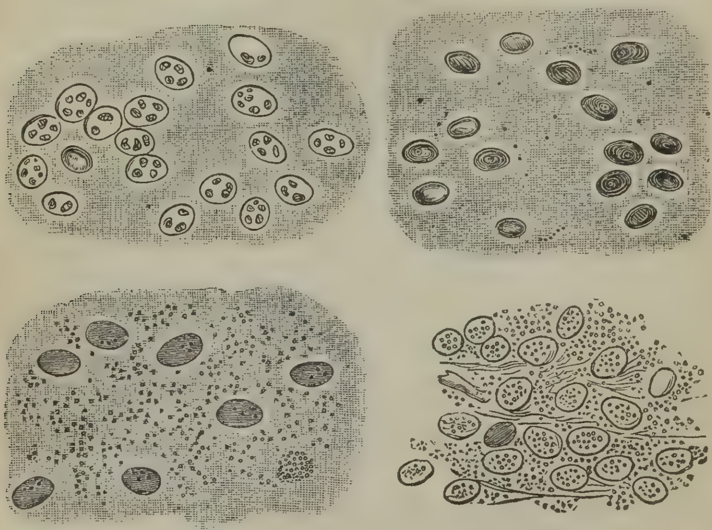


FIG. 26.—Fragmentation of Nucleus in Leucocytes undergoing Transformation into Pus-corpuscles (Senn).

very acrid, corroding the parts that it comes in contact with. It is found notably in caries and carcinoma.

Concrete or *fibrinous pus*, which contains flakes of fibrin or coagulated fibro-purulent masses, is met with in serous cavities (joints, pleura, etc.). These masses are found in infective endocarditis (Bowditch).

Blue pus.—The color of blue pus is due to the bacillus pyocyaneus.

Orange pus, which is due to hæmatoidin, follows violent inflammations in which red as well as white corpuscles are

exuded, these corpuscles being broken up by the pyogenic cocci.

Serous pus is a thin serous fluid containing a few flakes.

Scrofulous or *curdy pus* is not pus at all, unless the tubercular area has undergone pyogenic infection.

Gummy pus arises from the breaking down of a gumma which has outgrown its own blood-supply. It is not pus.

Muco-pus is found in purulent catarrh, that is, in suppurative inflammation of an epithelial structure. It contains pus-elements and epithelial cells.

Caseous pus comes from the fatty degeneration of pus-corpuscles or inflammatory exudations. This mass may calcify. It occurs in tuberculous processes.

Contagious pus is that which contains and conveys the elements of some specific contagion, such as small-pox or a chancroid.

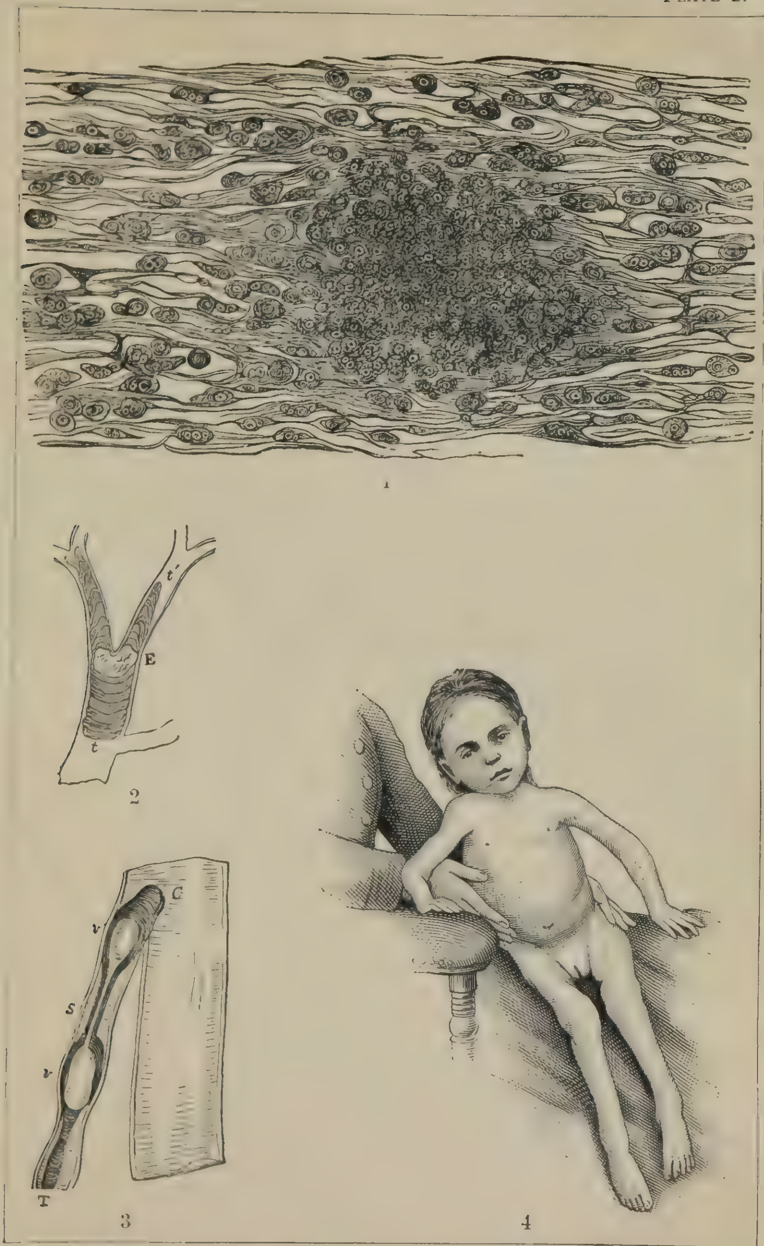
Suppuration is announced by the intensification of all inflammatory signs. Irregular chills and drenching sweats are very significant of suppuration in an important structure or of a wide area. The heat becomes intense, the discoloration becomes dusky, the swelling is much augmented, the pain becomes throbbing or pulsatile, and there is an increasing sense of tension. The skin at the focus of the inflammation becomes adherent to the parts beneath, and fluctuation soon appears. This adhesion of the skin is a preparation for a natural opening, and is what is known as "pointing." An important sign of pus beneath is œdema of the skin. This is noticeable in empyema or pyothorax and appendicitis. The above symptoms can be reinforced and their significance proved by the introduction of an exploring-needle and the discovery of pus.

Diffused Cellulitis or Phlegmonous Suppuration: Purulent Infiltration.—This process may involve a small area or an entire limb. It is announced in severe cases by enormous

swelling, the development of areas which feel boggy, a dusky-red discoloration, great burning pain, and probably chills, sweats, and fever. Gangrene of superficial areas is not unusual. The discharges of the wound, if a wound exists, dry up, and the wound becomes dry and brown. The adjacent lymphatic glands are much enlarged. We find diffused suppuration in infected compound fractures, in extravasation of urine, and after the infliction of a wound upon a person broken down in health. It is not unusual after scarlet fever, and is typical of phlegmonous erysipelas. The pus is sanious and offensive. This diffused suppuration may widely separate muscles, and even lay bare the bones. It is a very grave condition, and may cause death by exhaustion, septic intoxication, septic infection, pyæmia, or hemorrhage from a large vessel which has been corroded. Cellulitis of a mild degree may surround an infected wound or a stitch-abscess. Its spread is manifested by red lines of lymphangitis running up to the adjacent lymphatic glands. Light cases may not suppurate, the lymphatics carrying off the poison. Any case of cellulitis is, however, a menace, and any severe case is highly dangerous (see *Erysipelas*).

Abscesses.—An abscess is a circumscribed cavity of new formation containing pus. We emphasize the fact that it is a *circumscribed cavity*—circumscribed by embryonic tissue. A purulent infiltration is not circumscribed, hence it does not constitute an abscess. An essential part of the definition is the assertion that the pus is in a cavity of *new* formation, in an abnormal cavity; hence pus in a natural cavity (pleural, pericardial, synovial, or peritoneal) constitutes a purulent effusion, and not an abscess.

An acute abscess is due to the deposition and multiplication of pyogenic cocci in the tissues or in inflammatory exudates. These cocci attack exudates or tissues, form irritants which intensify the inflammation, and by exerting a



1. Infiltration of Connective Tissue of Cutis (× 500), with beginning suppuration in the centre (Senn). 2. Embolus Impacted at Bifurcation of a Branch of the Pulmonary Artery (Green). 3. Thrombus in the Saphenous Vein (Green). 4. Marasmic Rickets (Pye).

peptonizing action on intercellular substance and fibrin of the exudate liquefy tissue and the products of inflammation and form pus. Within twenty-four hours after their lodgment the exudation increases in amount, the migrated leucocytes are found in enormous numbers, the fibres of tissue swell up, and the connective-tissue spaces are distended with cells and fluid. The connective-tissue cells, acted on by pus cocci, multiply by karyokinesis, develop many nuclei, lose their stellate projections, degenerate, and constitute one form of pus-corpuscle, leucocytes forming the rest. All the small vessels are choked with leucocytes, this blocking serving to cut off nourishment and tending to produce anæmic necrosis. Liquefaction occurs at many foci of the inflammation, drops of pus being formed, the amount of each being progressively added to and many foci coalescing (Pl. 2, Fig. 1). The pus-cavity is circumscribed, not by a secreting pyogenic membrane, but by embryonic tissue whose cells and intercellular material have not as yet broken down, and this area of embryonic tissue is circumscribed by a zone of inflammation. As an abscess increases in size the embryonic tissue from within outward liquefies into pus, and the zone of inflammation beyond continually enlarges and forms more lymph. After a time the inflammation reaches the surface, the embryonic tissue glues the superficial to the deeper parts, liquefaction of this lymph occurs, a small elevation due to fluid pressure appears (pointing), and this elevation thins and breaks from tension and liquefaction (spontaneous evacuation). When an abscess forms in an internal organ or in some structure which is not loose like connective tissue—for instance, in a lymphatic gland—a mass of pus cocci, floating in the blood or lymph, lodges, and these cocci by means of irritant products cause coagulation necrosis of the adjacent tissue and inflammatory exudation around it. The area of coagulation necrosis becomes filled with white blood-

cells, and the dry necrosed part is liquefied by the cocci. Suppuration in dense structures causes considerable masses of tissue to die and to be cast off, and these masses float in the pus. Death of a mass with dissolution of its elements is necrosis or inflammatory gangrene.

Forms of Abscesses.—The following are the various forms of abscesses: *acute* or *phlegmonous*, which follows an acute inflammation; *strumous*, *cold*, *lymphatic*, *tubercular*, or *chronic* abscess is due to tubercle, and does not contain true pus without there is secondary infection. It presents no signs of inflammation. A lymphatic abscess may form in a week or two, and hence is not necessarily chronic, which term may mean a persistent non-tubercular abscess; *caseous* or *cheesy* abscess, a cavity containing thick cheesy masses, is due to the breaking down of tubercular matter; *circumscribed* abscess is one limited by embryonic tissue; *diffused* abscess is a collection of pus unlimited by lymph; *congestive*, *gravitative*, *wandering*, or *hypostatic* abscess is a condition in which the pus travels from its formation-point and appears at some distant spot (as a psoas abscess); *critical* or *consecutive* abscess is one which arises during an acute disease; *diathetic* abscess is due to a diathesis; *embolic* abscess is due to infected emboli; *tympanitic* or *emphysematous* abscess is one which contains the gases of putrefaction; *encysted* abscess, in which pus is circumscribed in a serous cavity; *fecal* or *stercoraceous* abscess is one containing feces because of a communication with the bowel; *follicular* abscess is one arising in a follicle; *hæmatic* abscess is that which arises around blood-clot, as a suppurating hæmatoma; *marginal* abscess, which appears upon the margin of the anus; *pyæmic* or *metastatic* abscess is the embolic abscess of pyæmia; *milk* abscess is an abscess of the breast in a nursing woman; *ossifluent* abscess, arising from diseased bone; *psoas* abscess, arising from vertebral caries, following the psoas muscle and

usually pointing in the groin; *sympathetic* abscess, arising some distance from the exciting cause, such as a suppurating bubo from chancroid; *thecal* abscess is suppuration in a tendon-sheath; *tropical* abscess is an abscess of the liver, so named because it occurs in tropical countries. It usually follows dysentery; *urinary* abscess, caused by extravasated urine; *verminous* abscess, one which contains intestinal worms and communicates with the bowel; *syphilitic* abscess, which occurs in the bones during tertiary syphilis; *Brodie's* abscess is a chronic abscess of a bone, most common in the head of the tibia; *superficial* abscess, which occurs above the deep fascia; *deep* abscess, occurring below the deep fascia; and *residual* or *Paget's* abscess, a recurrence of suppuration, it may be after years, about the residue of a former abscess.

Acute Abscess.—In an acute abscess a part becomes inflamed and embryonic tissue forms; this is liquefied (as above noted) and laudable pus is produced. If the abscess is in the brain, in the tonsils, or in the neighborhood of the rectum, the odor of the pus is apt to be offensive. An acute abscess can occur in a person of any constitution.

Symptoms: Local Symptoms.—Locally there is intensification of inflammatory signs: swelling enormously increases, the discoloration becomes dusky, the pain becomes throbbing and the sense of tension increases, and the cutaneous surface is seen to be polished and œdematous.

Constitutional Symptoms.—In cases of small collections of pus in unimportant structures there may be no obvious constitutional disturbance. If the abscess contains much pus or affects an important part, generally disturbances appear, from slight rigors or moderate fever to chills, high temperature, and drenching sweats. The constitutional condition typical of an abscess is due to the absorption of retained elements of pus, and this is known as "suppurative fever." When suppuration is long continued, there exists a fever which is

markedly periodic: the temperature rises in the evening, attaining its highest point usually between 4 and 8 P. M., and then sinks to normal or nearly normal in the early morning (from 4 to 8 A. M.). When the temperature begins to fall profuse perspiration takes place. This fever is known as "hectic."

The symptoms of an abscess are somewhat modified by location. Bone never suffers from acute abscess; sudden and violent inflammations produce necrosis, and all bone-abscesses are chronic—that is, slow in formation and prolonged in duration. Pain is continued, but not usually severe; it is boring in character and variable in intensity, being worse at night. Attacks of synovitis are apt to arise in the adjacent joint. In abscess of a silent region of the brain, symptoms may long be entirely absent. The usual symptoms are headache, vomiting, delirium, drowsiness, optic neuritis, and often a subnormal temperature. Localizing symptoms may be present. In but few cases are there fever and sweats.

Appendicinal abscess results from ulceration and perforation of the vermiform appendix, aplastic peritonitis circumscribing the pus. Its signs are pain, tenderness, often swelling, dulness on percussion, and sometimes fluctuation and skin-œdema in the right iliac fossa, fever, vomiting, sometimes constipation, and sometimes diarrhœa. Stercoraceous vomiting does not occur.

Abscess of the liver may not be announced by symptoms until rupture. We may find fever of an intermittent type, profuse sweats, pain in the back, the shoulder, or the right hypochondriac region, enlargement of the area of liver-dulness, hepatic tenderness, and finally sepsis. Sometimes there is fluctuation and skin-œdema, the skin being a little jaundiced. The symptoms vary as the pus invades adjacent organs.

Abscess of the lung gives the physical signs of a cavity; the expectoration is offensive and contains fragments of lung-tissue. Pyæmic abscesses may not be discovered.

Abscess of the mediastinum causes throbbing retro-sternal pain, chills, fever, sweats, and often dyspnœa. A tumor may appear which pulsates and fluctuates.

Perinephric abscess usually causes tenderness and pain in the lumbar region or about the hip-joint, running down the thigh and accompanied by retraction of the testicle. Induration, fluctuation, or œdema of the skin may appear. The constitutional symptoms of suppuration usually exist.

Retropharyngeal abscess causes cough, dyspnœa, pain on swallowing, dysphagia, and altered voice; an examination discloses a projection on the posterior wall.

Abscess of the antrum of Highmore causes pain, œdematous swelling, and crepitation on pressure.

Abscess of the larynx induces violent cough, pain, interference with the voice, swallowing, and breathing, and is seen with a laryngoscope.

Prostatic abscess is manifested by chills, fever, and sweats, developing during an attack of acute prostatitis.

Diagnosis.—The diagnosis of an abscess rests upon—(1) its history; (2) fluctuation; (3) pointing; (4) surface-œdema; and (5) the use of the exploring-needle.

A suspected abscess in a dangerous or important part under no circumstance should be opened by a bistoury without knowing that our diagnosis is certainly correct. This knowledge is obtained by inserting an exploring-needle and finding the nature of the fluid which exudes. An abscess made to move with the pulse by resting upon an artery may be confounded with an aneurysm. The pulse-movements of an abscess are in one direction only, it does not enlarge, and if a finger is laid upon either side of it the fingers will be lifted, but not separated. The pulse-move-

ments of an aneurysm are in all directions; they are pulsatile, the tumor grows larger, and the fingers will not only be lifted, but will also be separated. The exploring-needle must be used: it will do no harm to an aneurysm if aseptic. A rapidly-growing, small-celled sarcoma feels not unlike an abscess; but the exploring-needle discovers blood, and not pus. A cystic tumor is separated from an abscess by the absence of inflammation, or, if it inflames, by the nature of the fluid it contains. Ordinary caution will prevent us from confounding an abscess and strangulated hernia. A cold abscess is separated from an acute abscess by the absence of inflammatory signs.

Prognosis.—The prognosis varies according to the number of abscesses, their location and size, and the strength of the patient.

Treatment.—In the treatment of an abscess there is one absolute rule which knows no exception, namely, that whenever and wherever pus is found the abscess should be evacuated at once, and, after evacuating it, thorough drainage provided for. It should be opened early, if possible even before pointing or fluctuation, to prevent tissue-destruction, subfascial burrowing, and general contamination. In purulent effusion into the pleural cavity (empyema or pyothorax), resect a portion of a rib, cut away periosteum, incise the pleura, evacuate the pus, wash out the cavity first with a 14-volume solution of peroxide of hydrogen diluted with an equal bulk of water, then with a 1 : 3000 solution of corrosive sublimate, then with boiled water; insert a drainage-tube, dress antiseptically, and immobilize the chest with a binder, washing out afresh every day. If there be a large pus-cavity, resect a portion of each overlying rib to permit of sinking in of the chest-wall and approximation of the sides of the pus-cavity (Estlander's operation). Operations by the trocar or aspirator are rarely curative. In purulent perito-

nitis, open the abdomen and flush well with boiled water, insert a drainage-tube, and wash out the abdomen every day.

Abscess of the liver requires that an incision be made along the edge of the ribs down to the liver, which organ is then stitched to the edges of the wound, the abscess opened and washed out, and a tube inserted. Appendicular abscess, abscess of lung, of mediastinum, etc., like all other abscesses, require incision and drainage. In abscess of the brain the skull should be trephined, the membranes incised, and the abscess sought for, opened, and drained. In bone-abscess the bone must be trephined. In an ordinary superficial abscess, after cleansing the parts, make the skin tense, incise with a sharp-pointed curved bistoury, and let the pus run out itself, pressure being, as a rule, undesirable. If tissue-shreds block up the opening, they must be picked out with forceps. If the atmospheric pressure will not cause the pus to flow out, make light pressure with warm, moist, aseptic sponges. After the pus has come away, wash the cavity with peroxide of hydrogen and then with corrosive solution (1 : 1000), and pack with iodoform gauze for two or three days, when the discharge becomes serous. Pursue rigid antisepsis in dealing with pus. It is true we already have infection, but we can easily infect with organisms of putrefaction, making putrid pus. In a deep abscess always use a drainage-tube for several days.

In a deep abscess or an abscess situated near important vessels, do not boldly plunge in a knife. Hilton says to "plunge in a knife is not courageous, as it is without danger to the surgeon, but may be fatal to the patient." Remember also that a large amount of pus displaces normal anatomical relations. Hilton's method of opening a deep abscess (as in the axilla or neck) is to cut through the deep fascia and then to push into the abscess a grooved director until pus shows in the groove; along this groove push a pair of dress-

ing-forceps, shut; after they reach the depths open them and withdraw, and so dilate the opening; then insert a tube and wash. In an abscess in the posterior part of the orbit, after incising transversely a portion of the upper lid, the abscess should be reached by this method. Always endeavor to open an abscess at its most dependent part, remembering that this may depend upon whether the patient is erect or recumbent. If we do not make the opening at the lowest point, all the pus will not run out and the walls will not completely collapse.

In post-pharyngeal abscess opening through the mouth is dangerous, as pus may enter the larynx. In these cases it is better, as Hilton advised, to cut down through the sterno-cleido-mastoid muscle to the fascia below it and push the director and forceps through this into the abscess. When an abscess contains diverticula or pouches, the latter should be slit up or a counter-opening be made. A counter-opening is made by entering the dressing-forceps at our first incision, pushing them through the abscess to the point where we wish to make our counter-opening, opening the blades, and cutting between them from without inward. The blades are then closed and projected through the incision; they are opened to dilate the new door, and closed again upon a drainage-tube which is pulled through from opening to opening as the instrument is withdrawn. In empyema from a wound make a counter-opening by resecting a rib. When pus burrows, insert a grooved director in each channel and slit it up with a knife.

Rest is of the first importance in the healing of an abscess, and we try to obtain it by bandages, splints, and pressure which will immobilize adjacent muscles and approximate the abscess-walls. If an abscess is slow to heal, use as a daily injection peroxide of hydrogen followed by 1 : 500 corrosive sublimate, or 3 drops of nitric acid to ℥j of water,

or 3 grains of zinc sulphate to ℥j of water, or a 5 per cent. solution of carbolic acid, or a solution of pyoktanin, ʒj of the concentrated solution to Oj of water, or 20 drops of tincture of iodine to ℥j of water. The constitutional treatment of an abscess depends upon its severity and upon the importance of the structures involved. In a bad case the patient should be put to bed, opiates given with a free hand, the bowels kept active by calomel and salines, skin-activity maintained, nutritious food insisted on, and stimulants liberally employed.

Tubercular abscess, called also chronic, cold, scrofulous, and lymphatic, is an abscess circumscribed by a distinct membrane. Ashurst says that the term "chronic" is a bad one. "It refers etymologically only to time. A phlegmonous abscess, if deeply seated, may be of slower development than a chronic or cold abscess which is superficial." A tuberculous abscess is most common in the lymphatic glands, bones, joints, and subcutaneous connective tissues, and is rare after the twentieth year. It may contain quarts of curdy pus. The bacilli of tubercle cause inflammation, and embryonic tissue is formed, which undergoes coagulation necrosis and caseation because of the irritation of ptomaïnes and anæmia due to the mass outgrowing its own blood-supply. First there forms from embryonic tissue a cheesy matter which is liquefied into scrofulous, curdy, or tubercular pus. This really is not pus, as the tubercle bacillus is not pyogenic; if true pus forms, it is because of a secondary infection with pus cocci—an accident, and not a part of the natural process of formation of a cold abscess. A cold abscess may be absorbed, or may become encapsuled by fibrous organization of its limiting lymph into the pyogenic membrane.

Symptoms.—The term *cold* abscess is employed for a tubercular abscess because it presents no inflammatory signs. There is no local heat; no discoloration unless pointing

occurs; the parts look paler than natural; pain is absent in the abscess, though it may exist at the point of origin of the pus; the pus wanders from its point of origin under the influence of gravity; fluctuation is present unless thick walls mask it. Constitutional symptoms are absent unless secondary infection occurs. The tumor may suddenly appear in some spot—the groin, for instance. The abscess may last for years without producing pain or annoyance. The exploring-needle will settle the diagnosis. The constitution is invariably below normal because of the tuberculous infection, and the temperature is a little above normal. A cold abscess which is infected with pus cocci exhibits great inflammation, and fever rapidly develops. In tubercular disease of the vertebra the fluid may find its way to the lumbar region, to the iliac region, or to the immediate neighborhood of Poupart's ligament, above or below it.

Retro-pharyngeal or *post-pharyngeal abscess* is usually due to caries of the cervical vertebra. A tumor projects from the posterior pharyngeal wall, and there is great interference with respiration and deglutition. Pus from caries of the cervical vertebræ may reach the posterior mediastinum by following the œsophagus, or it may appear in front of or behind the sterno-mastoid muscle (Edmund Owen).

Dorsal Abscess.—The pus in dorsal abscess arises from dorsal caries, flows into the posterior mediastinum, and reaches the surface by passing between the transverse processes. The pus from dorsal caries may run forward between the intercostal muscles or between these muscles and the pleura, pointing in an intercostal space at the side of the sternum or by the rectus muscle. It may open into the gullet, windpipe, bronchus, pleura, or pericardium. It may descend to the diaphragm and travel under the inner arcuate ligament to form a psoas abscess, or under the outer arcuate ligament to form a lumbar abscess. A psoas abscess points

external to the femoral vessels, and is thus distinguished from a femoral hernia.

Iliac abscess comes from lumbar caries, the tumor lying in the iliac fossa and pointing above Poupart's ligament.

Psoas abscess is usually due to lumbar caries, the pus pointing in Scarpa's triangle external to the femoral vessels. A psoas or iliac abscess by following the lumbo-sacral cord and great sciatic nerve forms a gluteal abscess. These abscesses may open into the bowel, bladder, ureter, or peritoneal cavity.

Lumbar Abscess.—In a lumbar abscess the pus from dorsal caries descends beneath the outer arcuate ligament, or the pus from lumbar caries which collected anterior to or in the quadratus lumborum muscle flows backward between the last rib and iliac crest in the triangle of Petit.[1]

Treatment.—If a small cold abscess exists in a superficial structure, open it with aseptic care, curette its walls, wash out with 1 : 1000 mercurial solution, pack with iodoform gauze, and dress antiseptically. In a day or two remove the gauze, but continue mercurial dressings. If it be slow in healing, inject or swab out with a stimulating fluid as in acute abscess.

Cold Abscess of Lymphatic Glands.—In non-exposed portions of the body the capsule should be incised, dissected and scraped away, and the cavity swabbed out with pure carbolic acid and packed with iodoform gauze. If the abscess is allowed to burst, it will make an ugly scar; therefore in exposed portions of the body an effort should be made to prevent a scar. When only a little pus exists and the skin is not discolored, prepare the parts antiseptically and carry a silk thread by means of a needle through the skin, through the gland, and out at its lowest point. Dress

[1] For a lucid description of these abscesses see Owen's *Manual of Anatomy*, from which the above is condensed.

with gauze. In three days the thread can be taken out and a firm compress applied. When the gland is almost entirely broken down and the skin above it is purple and thin, insert a hypodermatic needle through sound skin into the abscess, draw off the pus, and inject iodoform emulsion (10 per cent. of iodoform, 90 per cent. of glycerin or olive oil). This procedure is to be repeated when pus again accumulates. By this means we can often effect a cure in a week or so. When an abscess breaks or is at the point of breaking, cut away all purple skin, curette the abscess-walls (the abscess having become a scrofulous ulcer), remove all remains of gland and capsule, swab it with pure carbolic acid, and dress with iodoform and corrosive gauze.

Large Cold Abscesses.—In view of the facts that these abscesses may cause no trouble for years and that an operation may be fatal, some eminent surgeons are opposed to an operation unless the abscess is marching toward inevitable rupture or is disturbing the functions of organs by pressure. Most practitioners believe, however, that this mass of tuberculous matter is a source of danger through being a depot of infective organisms which may overwhelm the system, and that death will not occur in the hands of the operator who employs with intelligence strict antisepsis. In no other cases is attention to every detail more important, as infection is very easy, and probably means death.

In many cases aspiration can be employed to empty the cavity, after the pus runs out, injecting either a 10 per cent. iodoform emulsion to the amount of ℥iij, or ℥iij of a 5 per cent. ethereal solution of iodoform. After injecting the emulsion squeeze and manipulate the fluid into every nook and cranny. The *American Text-book of Surgery* advises the injection of from 1 to 3 ounces of the following preparation: Iodoform, 10 parts; glycerin, 20; mucil. gum Arab., 5; carbolic acid, 1; water, 100.

Whatever fluid is chosen, the operation must be repeated three or four times at intervals of four weeks. It is dangerous to inject large amounts of iodoform, as poisoning will be produced. When iodoform poisons, the patient has a metallic taste in his mouth, subjective foul odors in the nose, the nose and eyes water, and the stomach is disturbed. In bad cases we find insomnia, loss of memory, variable emotions, headache, and violent mania alternating with coma. If aspiration and injection fail, open, under rigid antisepsis, the most dependent portion of the abscess, scrape it well, and over-distend with a 1 : 1000 solution of warm corrosive sublimate, which should be washed out with warm boiled water. With a long probe find the highest point of the cavity, and make a counter-opening, scrape well, search for and remove carious bone, flush out the whole area with corrosive sublimate, wash out this mercurial solution with boiled water, and either make tube-drainage from opening to counter-opening and from bone to counter-opening or pack the entire cavity with iodoform gauze. If hemorrhage is severe, after injecting with hot water the opening must be packed. When a large abscess breaks of itself, it should at once be drained and asepticized as above. In the treatment of a cold abscess give nutritious food, cod-liver oil, quinine, iron, and the mineral acids. Removal to the sea-side is often indicated, and mechanical appliances may be needed for diseases of the bones and joints. If secondary infection does occur, the patient develops hectic fever (q. v.).

VI. ULCERATION AND FISTULA

An ulcer is a loss of substance due to necrosis of a superficial structure. The action of the pus cocci is the same as in an abscess. A broken abscess becomes an ulcer, and an ulcer is a half-section of an abscess. The floor of an

ulcer consists of embryonic tissue and corresponds with the abscess-wall. An abscess arises from molecular death in the tissues; an ulcer, from molecular death of a free surface. An ulcer must not be confounded with an excoriation. In an ulcer the corium is always, and the subcutaneous tissue is generally, destroyed, and a scar is left after healing. In an excoriation the mucous layer of epithelium is exposed, or this is destroyed and the corium exposed. The corium is never destroyed, and no scar remains after healing.

Necrosis can arise from—(1) Inflammation. The pressure of the exudate can cut off the circulation, or bacteria may directly destroy tissue. Suppuration occurs. (2) The action of pus cocci, causing primary cell-necrosis. (3) Bacteria of putrefaction and cocci of suppuration acting upon a wound. (4) Traumatism or irritants, producing at once stasis, which is added to by secondary inflammation, the exudate undergoing purulent liquefaction. (5) Prolonged pressure. (6) Deficient blood-supply. (7) Faulty venous return. (8) Degeneration of a neoplastic infiltration (gummatous, malignant, or tubercular). (9) Trophic disturbance. (10) Nutritional disturbances (as scurvy). Most ulcers are due to pus cocci, and even those that arise from something else (as gummatous degeneration) are apt to suppurate.

Classification.—Ulcers are classified into groups according to the condition of the ulcer and the associated constitutional state. In the first group we find the varicose, hemorrhagic, acute, chronic, irritable, neuralgic, etc. In the second group are placed the strumous, syphilitic, senile, scorbutic, etc. All ulcers, whatever their origin, are either *acute* or *chronic*, and such conditions as great pain, hemorrhage, œdema, exuberant granulations, phagedæna, sloughing, struma, gout, syphilis, scurvy, etc. are to be looked upon as complications. The leg is so common a site of ulcers as to warrant special description.

Acute ulcer of the leg may follow an acute inflammation and may be acute from the start, or may be first chronic and become acute. It is characterized by rapid progress and intense inflammation. In shape these ulcers are usually oval. The bottom of an acute ulcer is covered with a mass of gray aplastic lymph, or it may have upon it large greenish sloughs. The edges are thin and undermined. The discharge is very profuse and ichorous, excoriating the surrounding parts. The adjacent surface is inflamed and œdematous. There is much burning pain. When the ulcer spreads with great rapidity and becomes deeper as well as larger in surface-area, it is called "phagedænic." If sloughs form, this indicates that tissue-death is going on so rapidly that the dead portions have not time to break down and be cast off. Limited stasis produces molecular death; more extensive stasis, a slough. Constitutionally, there is gastro-intestinal derangement, but rarely fever.

Treatment.—In treating an acute ulcer of the leg, give a dose of blue mass or calomel, followed in eight or ten hours by a saline (ʒij each of Rochelle and Epsom salt). Order light diet. Deny stimulants except in diphtheritic ulcer. Administer opium if pain is severe. Use a spray of peroxide and the scissors and forceps to get rid of sloughs, and after their removal wash the ulcer with corrosive sublimate. If the sloughs cannot be removed, use the antiseptic poultice. After asepticizing, local bleeding is of great value. Tie a fillet below the knee, make multiple punctures, and let the patient sit with his leg in tepid water until eight or ten ounces of blood have been lost; then untie the fillet and dress with antiseptic poultices, keeping the leg elevated. In two days paint around the ulcer with equal parts of tincture of iodine and alcohol, and repeat this treatment every day, dressing the ulcer with iodoform, covering it with gauze, and producing pressure by means of a roller.

Many cases do very well on the local use of lead-water and laudanum and the roller after bleeding. If the discharge is offensive, use gr. iij of chloral to every ℥j of lead-water. The use around an acute ulcer of a 25 per cent. ointment of ichthyol is highly valuable. If sloughs continue to form, touch with a 1 : 8 solution of acid nitrate of mercury or with a pure solution of carbolic acid and reapply antiseptic poultices. If an ulcer continues to spread, clean it up with peroxide of hydrogen, dry with absorbent cotton, touch with nitrate-of-mercury solution (1 : 8), and apply a poultice. Do this every day until it ceases to extend and granulations begin to form.

In an ulcer covered with a great mass of aplastic lymph, touch it daily with solution of silver nitrate (gr. xl to ℥j) or with acid nitrate of mercury (1 : 15) and dress with iodoform and gauze. Give internally tonics, stimulants, and good food. In any case, when granulations form we should dress antiseptically with dry dressings, but we can employ a non-irritant ointment, such as cosmoline. If granulation is slow, touch every day with a solution of silver nitrate (gr. x to ℥j) and dress antiseptically, or with a stimulating ointment (resin cerate or ʒj of ung. hydrarg. nitratis to ʒvij of ung. petrolii), or with an ointment of copper sulphate, gr. iij to ℥j, or with 3 drops of nitric acid to ℥j of gum Arabic or cotton.

Chronic ulcer of the leg is characterized by low action and slow progress. It may be chronic from the start, or it may result from acute ulcer. More usually it is found as a solitary ulcer two inches above the internal malleolus. Syphilitic ulcers occur in a group, are often crescentic, and are frequent upon the front of the knee. A chronic ulcer is circular or oval, and is surrounded by congested, discolored, and indurated skin, this induration being due to embryonic tissue, and there is often eczema or a brown pigmentation of the neighboring skin. The bottom of the ulcer is uneven, and

usually possesses granulations each of which is the size of a pin-point, red, and which may be exuberant or may be œdematous. If granulations are absent, the ulcer has the appearance of a bit of liver. The edges are thick, turned out, and not sensitive to the touch. Occasionally they are thin and undermined. Some ulcers are thick, indurated, and adherent; this prevents healing by antagonizing contraction.

Treatment.—In treating a chronic ulcer, give a saline every day or so. Treat any existing diathesis. Insist on rest and, if possible, elevation. Asepticize the ulcer. Draw blood by shallow scarifications of the bottom of the ulcer and the skin. If the ulcer is adherent, make incisions like either of those shown in Figure 27, each cut going through the deep fascia. These incisions, besides permitting contraction, allow granulations to sprout in them, which eventuate in the absorption of the exudate. After incision keep the part elevated and dressed antiseptically for two days. In two days after scarification or incision, scrape the ulcer with a curette until sound tissue is reached, and make radiating incisions through its edge. Use antiseptic poultices for two days more, then paint around the ulcer with tincture of iodine and alcohol (1 : 3) and dress the leg with hot lead-water and laudanum. When healing begins, treat as outlined for healing acute ulcer (p. 103).

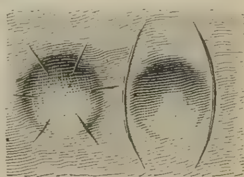


FIG. 27.—Incisions for Adherent Ulcer.

Complications.—Remove by scissors and forceps any useless tissue. Take out dead bone; slit sinuses; trim overhanging edges. Treat eczema by attention to the bowels and stomach, and locally by washing with Johnson's ethereal soap and by the use of powdered oxide of zinc or borated talcum, the leg being wrapped in cotton. Avoid ordinary soap, grease, and ointment. Varicose veins demand either ligation in several points, excision, obliteration with Vienna

paste, or the continued use of a flannel roller or a Martin bandage. Inflammation is met by rest, elevation, and painting the neighboring parts with dilute iodine, and by the use of a hot solution of lead-water and laudanum. For calloused edges employ radiating incisions or cut them away. Ordinary thick edges can be strapped. In strapping use adhesive plaster and do not completely encircle the limb. When the parts are adherent, completely or partly surround the sore with a cut through the deep fascia. If the bottom of the ulcer is foul, dry it and touch with a solution of acid nitrate of mercury (1 : 8) or with a solid stick of silver nitrate. Repeat this every third day and dress with an antiseptic poultice until granulations appear. Superfluous granulations (proud flesh) should be cut away or mowed down with silver nitrate.

When a man having an ulcer must go out, use a firmly-applied roller, or, better still, a Martin bandage. This bandage, which is made of red rubber, limits the amount of arterial blood going to the ulcer and favors venous flow from the sore and its neighborhood. The bandage should be used as follows: Before getting out of bed, spray the sore with hydrogen peroxide by means of an atomizer, dry off the froth with cotton, wash the leg with soap and water, dry it, and put on the bandage—all of which should be done before putting a foot to the floor. At night, after getting in bed, take off the bandage, wash with soap and water, and dry it, and again cleanse the leg and ulcer. If these rules are not strictly observed, the Martin bandage will produce pain, suppuration, and eczema of the leg. Irritable ulcer is due to exposure of a nerve and destruction of its sheath. Find with a probe the painful granulation and divide it with a tenotome, or curette the ulcer or burn it with solid stick of silver nitrate. If healing entirely fails, skin-graft. There are two methods of skin-grafting—(1) Reverdin's and (2) Thiersch's. (See *Plastic Surgery.*)

Ulcers in any Region.—*The fungous* or *exuberant ulcer* is especially common in burns and other injuries when cicatricial contraction causes venous obstruction. These granulations bleed when touched. Burn or cut them off with a sharp knife, stop hemorrhage if there be any, and strap or use the rubber bandage.

Erethistic, irritable, or *painful ulcers*, which are very sensitive, are due to the exposure of a nerve-filament. They are especially found near the ankle, over the tibia, in the anus (fissure), or in the matrix of the nail (in ingrowing nail). Curette an erethistic ulcer, and touch with pure carbolic acid or with the solid stick of silver. Chloral, gr. xx to the ounce, allays the pain; so does cocaine for a time.

Phagedænic Ulcer.—The phagedænic ulcer, which means the profound microbic infection of tissues debilitated by local or constitutional disease, is commonly venereal. This ulcer has no granulations and is covered with sloughs; its edges are thin and undermined, and it spreads rapidly in all directions. It requires the use of strong caustics or the Paquelin cautery followed by iodoform dressing. Internally, use tonics and stimulants.

A *rodent* or *Jacob's ulcer* is a superficial epithelioma developing from sebaceous glands, sweat-glands, or hair-follicles.

Decubital ulcer, or *bed-sore*, is due to pressure upon an area of feeble circulation.

Neuro-paralytic or *trophic ulcer* is due to impairment of the trophic centres in the cord.

The perforating ulcer, a name given by Vesigne, commonly affects the metatarso-phalangeal joint or the pulp of the great toe about a corn. The parts about the corn inflame, and pus forms which runs into the bone. A sinus evacuates the pus by the side of the corn.[1] As this ulcer may be present in anæsthetic leprosy, paralyzed limbs, and tabes

[1] See Treves in *Lancet*, Nov. 29, 1884.

dorsalis, and as the part on which it occurs is apt to be sweaty, cold, and possessed of impaired sensation, and as the sore may be hereditary, it is usually set down as trophic in origin. Treatment of a perforating ulcer consists, according to Treves, in going to bed and poulticing. Every time a poultice is removed the raised epithelium around the ulcer is cut away and then the poultice is reapplied. In about two weeks an ulcer remains surrounded by healthy tissue. Treves treats this sore with glycerin made to a creamy consistency with salicylic acid to each ounce of which ♏x of carbolic acid have been added. He directs the patient to wear during the rest of his life some form of bunion-plaster to keep off pressure. If in a perforating ulcer the bone is diseased, it must be removed. This ulcer tends to recur in the same spot or in adjacent parts, and it may be necessary to amputate the toe or the foot.

Epitheliomatous, sarcomatous, tuberculous, and syphilitic ulcers are considered under their respective heads.

Fistula.—A fistula is an abnormal communication between the surface and an internal part of the body, or between two natural cavities or canals. The first form is seen in a rectal fistula, a urethral fistula, or a biliary fistula, and the second form is seen in a vesico-vaginal fistula. Fistulæ may result from congenital defect, as when there is failure in the closure of the branchial clefts, sloughing, traumatism, and suppuration. Fistulæ are named from their situation and communications. (Fig. 166).

A sinus is a tortuous track opening usually upon a free surface and leading down into the cavity of an imperfectly-healed abscess. A sinus may be an unhealed portion of a wound. Many sinuses may be due to pus burrowing subcutaneously. A sinus fails to heal because of the presence of some fluid (as saliva, urine, or bile); because of the existence of a foreign body, as dead bone, a bit of wood,

a bullet, a septic ligature, etc.; or because of rigidity of the sinus-walls, which rigidity will not permit collapse. The walls of a tubercular sinus are lined with a material identical with the pyogenic membrane of a cold abscess. Sinuses may be due to the want of rest (muscular movements) and to general ill-health.

Treatment.—In treating a fistula remove any foreign body, lay the channel open, curette, swab with pure carbolic acid, and pack with iodoform gauze. Fresh air, good food, and tonics should be ordered.

VII. MORTIFICATION OR GANGRENE.

Mortification or gangrene is death in mass of a portion of the living body—the dead portions being visible—in contrast to ulceration or molecular death, in which the dead particles are too small to be seen and are cast away. In gangrene the dead portions may either desiccate or putrefy. Gangrene may be due to tissue-injury, either chemical or mechanical, to failure of the general health, to circulatory impairment, or to microbic infection. Molar death of bone is called "necrosis." When the gangrened portion is entirely dead, the process is spoken of as "sphacelus."

Classification.—Gangrenes are divided into the following three great groups:

(1) *Dry gangrene*, which is due to circulatory interference, the arterial supply being decreased or cut off. As venous return is still active, all fluid is taken up from the tissues, which shrivel up and mummify.

(2) *Moist gangrene*, which is due to interference not only with arterial ingress, but also with venous return or capillary circulation, the dead parts remaining moist.

(3) *Septic gangrene*, arising from virulent septic matter coming from outside.

There are many gangrenous processes which belong under one or other of the above heads, namely: *congenital* gangrene, a rare form existing at birth; *constitutional* gangrene, arising from a constitutional cause, as diabetes; *cutaneous* gangrene, which is limited to skin and subcutaneous tissue, as in phlegmonous erysipelas; *gaseous* or *emphsematous* gangrene, in which the subcutaneous tissues are filled with putrefactive gases and crackle on pressure; *diabetic* or *glycæmic*, due to diabetes; *hospital* gangrene, which is defined by Foster as specific serpiginous necrosis, the tissues being pulpefied: some consider it a traumatic diphtheria; *cold* gangrene, a form in which the parts are entirely dead (sphacelus); *hot* gangrene, which presents some inflammation, as shown by heat; *idiopathic* gangrene, which has no ascertainable cause; *mixed*, which is partly dry and partly moist; *primary*, in which the death of the part is direct, as from a burn; *secondary*, which follows an acute inflammation; *multiple*, a gangrenous ecthyma; *pressure*, which is due to long compression; *purpuric* or *scorbutic*, which is due to scurvy; *Raynaud's* or *idiopathic symmetrical*, which is due to vascular spasm from nerve-disorder; *senile*, the dry gangrene of the aged; *venous* or *static*, which is due to obstruction of circulation, as in a strangulated hernia; *trophic*, which is due to nutritive failure by reason of disorder of the trophic nerves or centres; *thrombotic*, which is due to thrombus; *embolic*, which is due to embolus; and *decubital* gangrene, from bed-sores.

Dry or chronic gangrene, Pott's gangrene (Fig. 28), arises from deficiency of arterial blood. In a person with healthy arteries dry gangrene can result by injury of the main trunk of an artery (lodging of an embolus, ligation, or laceration). Gangrene only follows injury when the anastomatic circulation fails to sustain the part. When, for instance, an embolus lodges and causes gangrene, the case runs the following

course: Sudden severe pain at the seat of impaction, and also tenderness; pulsation above, but not below, this point; the limb below the obstruction is blanched, cold, and anæsthetic; within forty-eight hours, as a rule, the gangrene has mapped out its area; the limb becomes blue, reddish, greenish, and then black; the skin itself becomes shriveled and its outer layer stony or like horn. The entire part may become as dry as a mummy, but usually there are spots where some fluid remains, and these spots are soft and moist, and the dead tissue where it joins the living is sure to be moist. The contact of dead with living tissue causes

FIG. 28.—Chronic Gangrene of the Feet (Gross).

inflammation in the latter tissue, a bright-red line forms, and we have exudation, suppuration, and ulceration. This line of ulceration in the sound tissues is called the "line of demarcation," it being Nature's effort at amputation, which in time may get rid of a large portion of a limb, and then heal as any other ulcer.

Senile gangrene is a form of dry gangrene due to feeble action of the heart plus obliterating endarteritis or atheroma of peripheral vessels. The vessels do not properly carry blood, and may at any time be occluded by thrombosis. Senile gangrene most often occurs in the toe or the foot.

Symptoms.—A man whose vessels are in the state above indicated is generally in feeble health and has a fatty heart and an arcus senilis (a red or white line of fatty degeneration around the cornea). His feet feel cold and numb, and they "go to sleep" very easily. The arteries are felt as rigid tubes like pipe-stems. A very slight injury of a toe will produce extensive inflammatory stasis, which completely cuts off the blood-supply and causes gangrene of the part. Gangrene is usually announced by a blue spot, followed by a vesicle which lets out bloody serum and has a dry floor. The tissues adjacent to the dead toe become victims to stasis and gangrene, and the process ascends until it reaches tissue whose circulation is sufficiently good to permit of ulceration instead of gangrene, when a line of demarcation forms. Before the line of demarcation forms there is some burning pain; after it forms pain is rarely present. If embolism in a diseased vessel caused the gangrene, the pain is severe. In senile gangrene the periphery is always dry, the part nearer the body being generally somewhat moist. A line of demarcation may start, but prove abortive, the tissue mortifying above it. This proves that tissue near the line is in a state of low vitality. An entire leg can die. When a limited area is gangrenous, constitutional symptoms are trivial or are absent, but when a large area is involved we find the fever of septic absorption. Death may ensue from exhaustion caused by sleeplessness and pain, from septic infection, or from embolism of internal organs.

Treatment of Senile Gangrene.—When injury of an artery causes us to fear dry gangrene, the patient should be placed in bed and the part relaxed, massage employed from time to time, and the part be kept wrapped up in cotton-wool and warmed with hot bottles or water-bags. If gangrene begins, wait for a line of demarcation and amputate well above it. While waiting for the line to form, dress the dead part antiseptically,

induce sleep, and give good food, tonics, and stimulants. If a person is of the type in which there is danger of senile gangrene, he should be cautioned against injuring his feet, especially cutting his corns carelessly, which is highly dangerous; any wound, however slight, requires rest and antiseptic dressing. He must wear woollen stockings, put a hot-water bag to his feet on cold nights, and attend to his general health. A little whiskey after each meal is indicated.

When gangrene occurs, if it shows a tendency to limit itself, we must wait for a line of demarcation and then amputate high up. If the gangrene shows no tendency to limit itself, or if the patient develops sepsis or exhaustion, at once amputate high up. The best point at which to amputate is above the knee, so that the deep femoral, which rarely occludes, will nourish the flap. Never amputate below the tubercle of the tibia. Some operators disarticulate at the knee-joint. Heidenhain affirms that so long as the gangrene is limited to one or two toes we should merely treat it antiseptically, elevate the limb, and wait for the dead part to be cast off spontaneously; if, however, it extends to the dorsum or sole of the foot, amputate at once above the knee. He further states that gangrene of the flaps almost always occurs in amputation below the knee, and high amputation is indicated in advancing gangrene with or without fever.[1]

In **moist** or **acute gangrene** (Fig. 29) the dead part remains moist and putrefies. It results from interference with venous return or capillary flow, as well as from arterial ingress. It is seen in a limb after ligature or destruction of its main artery and vein, after long constriction, and after crushes and lacerated wounds. Moist gangrene may follow acute inflammation, or may be due to local constriction (strangulated hernia), crushing, chemical irritants, heat, and cold.

Moist gangrene of a limb is seen typically when both vein

[1] *Deutsche medicinische Wochenschrift*, 1891, p. 1087.

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and artery are tied. The leg swells and is pulseless, the skin becomes cold and livid, and is raised up into blebs which contain sero-sanguineous fluid. The extremity swells enormously, there is pain at the seat of obstruction, and septic symptoms quickly develop. The bullæ break and disclose the deeper structures, which are swollen and œdematous. The fœtor is horrible. Portions of the extremity become emphysematous. A line of demarcation soon forms.

FIG. 29.—Acute Mortification (Gross).

Moist gangrene from inflammation is due to pressure of the exudate cutting off the blood-supply. It occurs in phlegmonous erysipelas. When an inflammation is about to terminate in gangrene, all the signs of inflammation, local and constitutional, increase; when gangrene occurs, they cease, bullæ appear, emphysema is noted, with great swelling and all the other symptoms.

Treatment of Moist Gangrene.—In moist gangrene of a limb we should wait for a line of demarcation and then amputate clear of and above it. Dress the dead parts antiseptically while waiting. Give opium, tonics, good food, and stimulants. In inflammatory gangrene relieve tension by incisions and then cut away the dead parts. Stimulate freely and feed well.

Septic gangrene is divided into—(1) traumatic spreading gangrene; (2) hospital gangrene; (3) phagedæna; (4) noma vulvæ; and (5) cancrum oris.

Traumatic spreading gangrene results from a virulent infection of a severe wound. It is commonest after compound fractures, and begins within forty-eight hours after the accident. It does not begin at the periphery, as does ordinary traumatic moist gangrene, but at the wound-edges, which turn red, green, and finally black. The entire limb swells from œdema, the skin peels away, and emphysema sets in. The gangrene spreads up and down from the wound, and in thirty-six hours may involve an entire limb. No line of demarcation forms. The system is soon overwhelmed with ptomaïnes, and the patient has septic intoxication, or he passes into profound collapse with subnormal temperature.

Treatment.—In treating traumatic spreading gangrene a line of demarcation need not be waited for, as none can form. Amputation should at once be performed high up and stimulants must literally be poured into the patient.

Hospital gangrene or sloughing phagedæna is a disease that has practically disappeared from civilized communities. It formerly occurred in crowded, ill-ventilated hospitals. Some consider it traumatic diphtheria. Koch thinks it is due to streptococci. Jonathan Hutchinson says, "Hospital gangrene is set up by admitting to the wards a case of syphilitic phagedæna." It may show itself as a diphtheritic condition of a wound, as a process in which form sloughs like masses of tow, or as a phagedænic ulceration. The surrounding parts are inflamed and painful, and buboes form in adjacent lymphatic glands. The system passes into a low septic state.

Treatment.—In treating hospital gangrene ether should be given, the large sloughs removed with scissors and forceps, the part dried with cotton and cauterized with bromine. Take a tumblerful of water and into it pour the bromine: this falls to the bottom; draw it up with a syringe and inject it into

the depths of the wound. Iodoform should be "shovelled" on and antiseptic poultices be used until the sloughs separate, when the sore is treated as an ordinary ulcer. If a limb is hopelessly damaged by this form of gangrene, we must wait for a line of demarcation and amputate.

Special Forms of Gangrene.—*Symmetrical* or *Raynaud's gangrene* arises in severe cases of Raynaud's disease. It is a dry gangrene. Raynaud's disease, a vaso-motor neurosis seen in children and young adults, is characterized by attacks of cold, dead bloodlessness in the fingers or toes as a result of exposure to cold or of emotional excitement (local syncope). In the more severe cases we may have capillary congestion and livid swelling (local asphyxia). Chilblains belong in this group. The patient complains of pain, tingling, and stiffness. It is after local asphyxia that the gangrene may appear.

This gangrene is usually seen upon the ends of the fingers or the toes, but it may attack the lobes of the ears, the tip of the nose, or the skin of the arms or the legs. When gangrene is about to occur, the local asphyxia at that point deepens, anæsthesia is complete, and the part blackens and becomes cold. The epidermis is now raised up into blebs, which rupture and expose dry surfaces. A line of demarcation forms, and the necrosed area is removed as a slough. Widespread gangrene from Raynaud's disease is rare; there is not often involved a large area—only a small superficial portion. Sometimes the disease is seen upon the trunk. These attacks recur again and again, are often accompanied by hæmoglobinuria (Osler), and are sometimes excited by cold or by mental disturbance. The pathology is uncertain. Local syncope is thought to be due to vascular spasm, and local asphyxia to some contraction of the arterioles with dilatation of the capillaries and venules.

Treatment of Raynaud's Disease.—When attacks of Ray-

naud's disease are so severe as to threaten gangrene, the patient should be put to bed; if the feet are affected, elevate the legs, wrap the extremity in cotton-wool, and apply heat. If the hands are affected, they should be elevated, wrapped up, and the arm and hand be warmed. Massage is useful. When gangrene occurs, dress the part antiseptically until a line of demarcation forms, and then dispose of the dead parts by scissors, forceps, and antiseptic poultices. If amputation becomes necessary, which will rarely be the case, wait for a line of demarcation.

Diabetic gangrene resembles in many points senile gangrene, but the dead portions remain somewhat moist and putrefy. Diabetic gangrene is most usually met with upon the feet and legs, but it may attack the genital organs, thigh, lung, buttock, eye, back, finger, or neck (Hunt). It may begin in a perforating ulcer, or, as in senile gangrene, a trivial injury is apt to be the exciting cause. It spreads slowly, but more rapidly than senile gangrene. There is little tendency to the formation of any line of demarcation. Surgeons have become shy of amputating in such cases, but the experience of Kuster of Berlin proves conclusively that an amputation should be performed at once in diabetic gangrene, and should be done above the knee. If we operate below the knee, the flaps will become gangrenous. It has been noted that sugar will sometimes disappear from the urine after an amputation. Of eleven amputations by Kuster, six recovered and five died; and of these five, three had albumin in the urine as well as sugar.[1]

Gangrene from ergotism is a peripheral dry gangrene arising from tonic vascular contraction produced by the ergot in bread made from diseased rye. The gangrene is preceded by anæsthesia, muscular cramp, tingling pains, itching, and

[1] See the convincing article of Chas. A. Powers in *Amer. Journal of Med. Sciences*, 11th Nov., 1892.

"gradual blood-stasis in certain vascular areas" (Osler). This form of gangrene occurs in epidemics where rye-bread is largely used, but is very rare in the United States. It usually affects the fingers or toes, but may involve an entire limb. In acute cases death occurs in from seven to ten days.[1] In chronic cases await a line of demarcation and then amputate.

Gangrene from Frost-bite.—When parts have been badly frozen, the peripheral parts dry up, being deprived of all blood because of contraction of the vessels. When a patient so afflicted is brought into a warm atmosphere, blood cannot run into the dead part, and the living tissues in contact with it inflame, forming a line of demarcation. Hence we note that severe frost-bite causes dry gangrene. If a part which is not so badly frozen is brought suddenly into a warm atmosphere, inflammation takes place when the blood runs into the deadened tissues, and moist gangrene results. A frost-bite in which the skin is livid and not as yet gangrenous should be treated by frictions with snow or towels soaked in iced water. As the skin becomes warmer and congestion disappears the part should be wrapped up in cotton-wool. A sufferer from frost-bite should not suddenly be brought into a warm room. When the parts are dead or when gangrene follows, if only small areas be involved, allow the dead part to come away spontaneously, wrapping it up in the mean while with antiseptics; if removal be delayed by cartilage, ligament, or bone, cut through the retaining structure. If amputation is necessary, await a line of demarcation, as we are not sure how high tissue-damage extends, and to amputate through devitalized parts would mean renewed gangrene.

Noma, or **cancrum oris**, is a gangrene beginning as a sloughing ulcer on the gums or cheeks, and affecting young

[1] Pick, in Heath's *Surgical Dictionary.*

children who live amid filth and squalor or who are convalescing from acute fevers. This disease may destroy large portions of the cheeks and jaws. The constitutional symptoms are diarrhœa, fever, and great exhaustion. Death is the usual result, due frequently to septic broncho-pneumonia (Bowlby). Lingard has found a bacillus which he believes is causative of noma.

The treatment of noma consists in destruction of the diseased tissue by nitric acid or the cautery, the use, locally and often, of peroxide of hydrogen and antiseptic washes, and, internally, the employment of good food, stimulants, and tonics.

Sloughing is a process of ulceration by which visible portions of dead tissue are separated. These visible portions are called "sloughs;" if they were large they would be called "gangrenous masses." A large slough is a gangrenous mass; a small gangrenous mass is a slough; there is no difference in the process, which corresponds to the formation of a line of demarcation. Sloughing requires thorough cleansing, removal of the sloughs, and antiseptic treatment.

Phagedæna is a process (most common in a venereal sore) in which the surrounding tissues are rapidly eaten up, the sore becoming jagged and irregular, with a sloughy base and thin edges; the discharge is thin and reddish, and the encircling tissues are deeply congested. This ulcer has no tendency to heal. It is due to a specific poison which is not yet isolated. *Noma vulvæ* is a form of phagedæna which attacks the genitals of little girls who are unhealthy, dirty, or convalescent from a specific fever.

The treatment of phagedæna consists in repeated touching with tincture of chloride of iron and the local use of iodoform, the employment of continued irrigation, or the application of the cautery, chemical or actual. Whatever else is done, tonics, stimulants, and nutritious diet must be given.

Decubital Gangrene or Bed-sore; Decubitus.—A bed-sore is the result of local failure of nutrition in a person whose tissues are in a state of low vitality from disease or from injury. Such sores are due to pressure, aided by the presence of urine, of fæces, and of sweat, to wrinkling of the sheets, or to the dropping of foreign bodies (such as crumbs) in the bed. These ordinary pressure-sores arise like splint-sores due to the pressure of a splint upon the tissues over a bony prominence. They occur over the heels, elbows, scapulæ, trochanters, sacrum, and nuchæ. The pressure interferes with the blood-supply, the weakened tissues inflame, vesication occurs, sloughs form, and an ugly ulcer is exposed.

The acute bed-sore of Charcot is seen during certain diseases and after some injuries of the nervous system. These sores are usual over the sacrum in acute myelitis, and may appear in four or five days after the beginning of a disease or the infliction of an injury. The surgeon sees acute bed-sores upon the buttock of the paralyzed side after brain-injuries, and over the sacrum in spinal injuries. Some believe these sores are due to vaso-motor disorder, but others, notably Charcot, attribute them to disturbance of the trophic nerves or centres.

Treatment of Bed-sores.—The "ounce of prevention" is here invaluable. From time to time, if possible, alter the position of the patient, keep him clean, maintain the blood-distribution of the skin by frequent rubbing with alcohol and a towel, and keep the sheet clean and smooth. When congestion appears (paratrimma, or beginning sore), at once use an air-cushion or a water-bed and redouble the care to frequently change the position of the patient. Not only protect, but also harden, the skin. Wash the part twice daily and apply spirits of camphor or glycerole of tannin; or rub with salt and whiskey (ʒij to Oj); or apply a mixture of ℥ss of powdered alum, f℥ij of tincture of camphor, and

the whites of four eggs; or paint with corrosive sublimate and alcohol (gr. ij to ℥j); or apply tannate of lead or equal parts of oil of copaiba and castor oil; or paint on a protective coat of flexible collodion.

When the skin seems on the verge of breaking, paint it with a solution of nitrate of silver (gr. xx to ℥j). When the skin breaks, a good plan of treatment is to touch once a day with silver solution (gr. x to the ounce) and cover with zinc-ichthyol gelatin. We can wash the sores daily with 1 : 2000 corrosive-sublimate solution, dust with iodoform, and cover with soap plaster, with lint spread with zinc ointment, or with dry aseptic gauze. When sloughs form, cut most of them off with scissors after cleaning the parts. Slit up sinuses. Use antiseptic poultices. In sloughing Dupuytren employs pieces of lint wet with lime-juice and dusted with cinchona and charcoal. In obstinate cases use the continuous hot bath or the intermittent ice poultice. When the sloughs separate, dress antiseptically or with equal parts of resin cerate and balsam of Peru. If healing is slow, touch occasionally with silver solution (gr. x to ℥j). Bed-sores, being expressive of lowered vitality, demand that the patient shall be stimulated, shall be well nourished, and shall have good sleep.

Rules when to Amputate for Gangrene.—In *dry* gangrene, due to embolus in a healthy artery, wait for a line of demarcation. In *senile* gangrene, if it affect only one or two toes, let the dead parts be cast off spontaneously. If a greater area is involved or the process spreads, amputate above the knee without waiting for the line. In *ordinary moist* gangrene wait for a line of demarcation. In *traumatic spreading* gangrene amputate at once. In *hospital* gangrene and in *Raynaud's* gangrene wait for a line of demarcation. In *diabetic* gangrene amputate at once, high up. In *ergot* gangrene and in *frost* gangrene wait for a line of demarcation.

VIII. THROMBOSIS AND EMBOLISM.

Thrombosis is the coagulation of blood in a vessel, which blood-clot remains at its point of origin and plugs up the vessel partially or completely. This process is an essential part in the arrest of hemorrhage; it occurs in phlebitis, and affords a frequent basis for embolism. We find thrombi in the veins, in arteries, and in the heart. Clotting is due to destruction of white blood-cells, a ferment being set free causing the union of the normal blood-albuminoids, fibrinogen and fibrinoplastin. Figure 3 (Pl. 2) shows a thrombosis.

Causes of Thrombus.—Retarded circulation is a cause in consumption, influenza, and fevers, the blood clotting behind the vein-valves. The pressure of a bandage or of a splint or the presence of varicose veins may cause thrombosis. Ligation also causes it. It may be produced by injuries of a vessel; by foreign bodies in a vessel; by atheroma in arteries; by sutures in a vessel; by certain diseases, such as gout, typhoid fever, pregnancy, and septic processes; by phlebitis or arteritis arising in the vessel or from extension of surrounding inflammation; and by entrance of specific organisms.

It has been asserted that so long as the endothelium of a vessel is uninjured a clot does not form. Slowing of the blood-current in aseptic conditions, it is now taught, will not cause thrombosis. When moving blood coagulates, the third corpuscles first settle out, and then the leucocytes. This is known as the white or "ante-mortem" thrombus—the clot of moving blood. Thrombi from moving blood are rarely pure white: they contain some red corpuscles, forming mixed thrombi. The red thrombus plugs vessels which are cut across or ligated; it occurs in septic processes, and takes place after death. A thrombus may be absorbed, first embryonic tissue and then fibrous tissue replacing it (organization). A thrombus may degenerate and break down (fatty degen-

eration), giving rise to emboli. A thrombus may undergo purulent liquefaction, infective emboli being set free.

Symptoms.—The symptoms are dependent on the seat of the obstruction. An organ or a part of an organ may exhibit functional aberration. The local signs in a vessel accessible to touch or sight are the presence of a clot, and, if it be an artery, anæmia and the absence of pulse below it; if it be a vein, swelling and œdema. There are usually pain and anæsthesia.

Treatment.—If in a limb, raise the limb, keep it perfectly quiet to avoid detachment of fragments (emboli), apply a bandage and heat, and paint with iodine or rub with ichthyol. The great danger is the formation of emboli, so avoid movements and rough handling.

Embolism signifies vascular plugging by a foreign body (usually a blood-clot) which has been brought from a distance. Emboli may arise either in the venous or in the arterial system, but lodge in an artery or in the veins of the liver. The initial thrombus may form upon diseased heart-valves or in a vein. It may be composed of fat, micro-organisms, air, or a portion of a tumor. An embolus is arrested when it reaches a vessel whose diameter is less than its own. It is usually caught just above a bifurcation. When an embolus lodges, it at once partially or entirely obstructs the circulation, and increases in size by thrombosis. A non-septic embolus usually organizes. A soft embolus may disintegrate and permit of re-establishment of the circulation. An embolus may cause an aneurysm. A septic embolus breaks down, forms a metastatic abscess, and sends other emboli onward. Figure 2 (Pl. 2) shows an impacted embolus.

An embolus is more serious than a thrombus: it causes sudden plugging which makes serious anæmia inevitable, and it may produce gangrene if the collateral circulation fails. In organs with terminal arteries (spleen, kidney, brain,

and lung) there is no collateral circulation if embolism causes infarction. The embolus produces an area of anæmia; the removal of all propulsion upon the venous blood causes it to flow back and stagnate, and vascular elements exude, forming a wedge-shaped area of red tissue, the embolus being the apex of the wedge. This is known as the "red infarction," and is often seen in the lung. The white infarction seen in the brain and kidney is not due to retrogression of venous blood, but is due to anæmia and resulting coagulation necrosis.

Symptoms.—The symptoms depend upon the organ involved. They are sudden in onset, and consist of loss of function which is permanent or is followed by inflammation or softening. Embolism of the cerebral arteries may cause aphasia, paralysis, or coma. Embolism of the pulmonary artery may cause almost instant death. Embolism of the central artery of the retina causes blindness. Embolism of a large artery of a limb produces symptoms identical with thrombus, except more sudden and decided.

Treatment.—The treatment depends upon the part involved. In a limb, rest, elevate, and keep it warm in order to stimulate the collateral circulation. If gangrene ensues, await a line of demarcation and amputate. After an operation upon veins (as in varicocele), after a cutting operation, and after fracture, avoid as much as possible movements or handling, as fragments of thrombus may be detached.

Fat-embolism is an accumulation in the capillaries of liquid fat, arising after injuries of adipose tissue, when we have high tension to force the fat into the open mouths of veins. Some fat may get into the blood by means of the lymphatics. Fat-embolism occurs in osteo-myelitis, after extensive bruises, crushes, or lacerations, and after amputations, fractures, resections, or rupture of the liver.[1] This

[1] G. H. Makins, in Heath's *Dictionary*.

fluid fat accumulates especially in the capillaries of the lung and brain.

Symptoms.—The symptoms are those of œdema of the lungs and exhaustion, often with coma or delirium. There are restlessness, dyspnœa, rapid pulse and respiration. If life is prolonged a day or two, oil is found in the urine. These symptoms never occur until at least twenty-four hours after the accident, and rarely before the third day. The symptoms occur at a later period than those of shock, and at an earlier period than those of ordinary embolism of the lung. Severe cases are commonly fatal; milder cases are often recovered from.

Treatment.—The treatment consists of the ordinary methods used in shock—stimulants, heat, etc., with dry cupping of the chest, diuretics, strychnine, and, it may be, artificial respiration. See that drainage of the wound, if an external wound exists, is good, and thoroughly immobilize the damaged part.

IX. SEPTICÆMIA AND PYÆMIA.

Septicæmia, or sepsis, is a febrile malady due to the introduction into the blood of septic organisms or their products. There is no one special causative organism, and any microbe which produces inflammatory and febrile products can cause it. Either streptococci or staphylococci are present. It arises by absorption of septic matter. Clinically we make two forms of septicæmia: (1) sapræmia, septic or putrid intoxication; and (2) septic infection, true or progressive septicæmia.

Sapræmia, or **septic intoxication,** is due to the absorption of poisonous ptomaïnes from a putrefying area. The bacteria do not enter the blood, but their toxines do, and, as these toxines are alkaloids, the condition is comparable to poisoning by successive alkaloidal injections, the symptoms and

prognosis depending upon the dose. Slight symptoms and recovery follow a small dose; grave symptoms and death follow a large one. The poison does not multiply in the blood, and a drop of the blood of a person laboring under putrid intoxication will not produce the disease when introduced into the blood of a well person; in other words, the disease is not infective. Sapræmia results from the absorption of putrid matter from considerable areas which are under high pressure. It may follow labor where putrid fluid is retained in the womb, or follow amputation where pus is pent up within the flaps. In this condition there always exist a considerable absorbing surface and a large amount of dead matter which has become putrid.

Symptoms.—In twenty-four hours or more after the delivery of a baby, after an injury, or after an operation there is a severe chill followed by high temperature, gastric disturbance, dry tongue, weak rapid pulse, great prostration, muscular twitching, restlessness, headache, often delirium, diarrhœa, drying up of wound-discharge, diminution or suppression of urine, and a strong tendency to congestion of various organs. Great elevation of temperature precedes death.

Treatment.—The treatment is to at once drain and asepticize the putrid area and give enormous doses of alcohol. Strychnine and digitalis are useful. Establish the action of the skin and kidneys; allay vomiting by champagne, cracked ice, calomel, cocaine, or carbolic acid with bismuth. Give food every three hours. Feed on milk, milk and lime-water, liquid beef-peptonoids, and other concentrated foods. Use quinine in stimulant doses. Antipyretics are useless. Watch out for any visceral congestion, and treat it at once.

Septic infection, or **true septicæmia**, is a true infective process. Intoxication exists, due in part to toxines introduced from the infected area, and also to toxines evolved by bacteria which have been taken into the blood. In sapræmia

the blood contains toxines, but not organisms. In septic infection the blood contains both toxines and organisms, the bacteria multiplying in it. The symptoms of sapræmia depend on the dose. In septic infection only a small number of organisms may get into the blood, but they multiply enormously. The pus microbes cause true septicæmia, and reach the blood chiefly through the lymphatics, but to some degree by penetrating the walls of vessels. A drop of blood from a man with septic infection will reproduce the disease when injected into the blood of an animal; hence it is a true infective disease. The wound in such cases is often small.

Symptoms.—The type of this condition is met with in puerperal septicæmia or a poisoned wound. It begins, in from four to seven days after labor or an injury, with a chill, which is followed by fever, at first moderate, but soon becoming high. The fever presents morning remissions and evening exacerbations, and may occasionally show an intermission. The pulse is small, weak, very frequent, and compressible. The tongue is dry and brown with a red tip. The vomiting is frequent, and diarrhœa is the rule. Delirium alternates with stupor, and coma is usual before death. Prostration is very great. Toward the end the face often becomes Hippocratic (p. 79). Congestions occur. Ecchymoses and petechiæ are noted, secretions dry up, urinary secretion is scanty or is suppressed, and the wound becomes dry and brown. Blood-examination detects disintegration of red globules. When a wound inaugurates septicæmia, red lines of lymphangitis are seen about it and there is enlargement of related lymphatic glands. No thrombi or emboli exist in septicæmia. The prognosis is bad, and death may occur within twenty-four hours. The *treatment* is the same as for septic intoxication.

Pyæmia.—Pyæmia, which is septicæmia plus metastatic abscesses, is characterized by fever of an intermittent type

and by recurring chills. It is not due to pus in the blood, but to the taking up of clots infected by streptococci and staphylococci.

In an area of suppuration there are coagulation necrosis, thrombosis, and septic inflammation of the adjacent vessels, and the thrombi are infected. A vessel-thrombus reaches up to the first collateral branch, and the apex of the purulent clot is broken off by the blood-stream from that branch and is carried as an embólus into the circulation. Many of these poisonous emboli enter into the blood and lodge in some vessels which are too small to transmit them, and at their points of lodgment form embolic, secondary, or metastatic abscesses. Wounds of the superficial parts and bones produce pyæmic infarctions or metastatic abscesses of the lungs. When these infarctions break into fragments particles may return to the heart and lodge there, or may be sent out through the arterial system to form another focus in the kidneys. Infected areas connected with the portal circulation (intestinal injuries or suppurating piles) produce abscess of the liver. Malignant endocarditis is called "arterial pyæmia," and is due to endocardial embolic infection. In this disorder infected emboli lodge in the kidneys, the spleen, the alimentary tract, the brain, or the skin (Osler). Idiopathic pyæmia is a misnomer. Some primary focus of infection must exist (often in the ear).

Symptoms.—The wound becomes dry, brown, and offensive. A severe and prolonged chill or a succession of chills usher in the disease; high fever follows, and a drenching sweat. These chills recur every other day, every day, or oftener. After the sweat the temperature falls and may become nearly normal. The general symptoms of vomiting, wasting, etc. resemble those of septicæmia. The skin becomes jaundiced, and a profound adynamic state is rapidly established. The spleen is enlarged. The lodgment of em-

boli produces symptoms whose nature depends upon the organ involved. Lodgment in the lungs causes shortness of breath and cough with slight physical signs. Lodgment in the pleura or pericardium gives pronounced physical evidence. Lodgment in the spleen produces severe pain and great enlargement. The parotid gland not unusually suppurates (as in the case of President Garfield).

In a suspected case of pyæmia always look for a wound, and if this does not exist, remember that the infection can arise from gonorrhœa, osteo-myelitis, suppuration of the middle ear, or abscess of the prostate. Chronic pyæmia may last for months; acute pyæmia may prove fatal in three days. The complications are joint-suppuration, broncho-pneumonia, pleuritis, endocarditis, pericarditis, peritonitis, venous thrombosis, and abscesses.

Treatment is the same as for septicæmia. Open, drain, and asepticize any wound and any accessible secondary abscess.

X. ERYSIPELAS (ST. ANTHONY'S FIRE).

Erysipelas is an acute, contagious, capillary lymphangitis due to the streptococcus of erysipelas, which grows and multiplies in the smaller lymph-channels of the skin and of serous and mucous membranes. It is characterized by a remittent fever and a tendency to recur. It is always due to a wound. Idiopathic erysipelas is due to a small wound which escapes notice. It may or may not suppurate. Suppuration, some say, does not require a mixed infection, as the streptococcus is identical with the *streptococcus pyogenes* (Osler, Koch); others think suppuration does require mixed infection, the streptococcus not being pyogenic. Erysipelas is most common in the spring and fall, and is most usually met with among those who are crowded into dark, dirty, and ill-ventilated quarters; it attacks by preference the debil-

itated and broken-down (as alcoholics and sufferers from Bright's disease). The poison of erysipelas will produce puerperal fever in a lying-in woman.

Forms of Erysipelas.—*Ambulant*, *erratic*, *migratory*, or *wandering* erysipelas is a form which tends to spread widely over the body, leaving one part and going to another. *Bullous* erysipelas is attended by the formation of bullæ. In *diffused* erysipelas the borders of the inflammation gradually merge into healthy skin. *Erythematous* erysipelas involves the skin superficially. *Metastatic* erysipelas appears in various parts of the body. *Puerperal* erysipelas begins in the genitals of lying-in women, producing puerperal fever. *Erysipelas simplex* is ordinarily cutaneous. *Erysipelas neonatorum* begins in the unhealed navel of a new-born child and spreads from this point. *Typhoid* erysipelas occurs with profound adynamia. *Universal* erysipelas involves the entire body. *Phlegmonous* erysipelas involves the skin and subcutaneous tissues, with suppuration, and often with gangrene. *Œdematous* erysipelas is a variety of phlegmonous erysipelas with enormous subcutaneous œdema. *Lymphatic* erysipelas is characterized by rose-red lines of lymphangitis. *Venous* erysipelas is marked by the dark color of venous congestion. *Mucous* erysipelas involves a mucous membrane. *Black tongue* is erysipelas of the fauces.

Clinical Forms.—The clinical forms are cutaneous erysipelas, cellulo-cutaneous or phlegmonous, and cellulitis.

Cutaneous erysipelas is ushered in by a chill which is followed by fever and sweat. Any wound which exists becomes dry and unhealthy, and its edges redden and swell. This combination of redness and swelling extends, and its area is sharply defined from the healthy skin. In the hyperæmic area vesicles or bullæ form, and œdema affects the subcutaneous tissues, producing great swelling in regions where they are lax (as in the eyelids). The anatomically

related lymphatic glands become large and tender, and between them and a wound are seen the red lines of inflamed lymphatic vessels. Erysipelas spreads at its periphery and fades at its point of origin. When spreading stops the swelling and redness gradually abate, and after they disappear desquamation takes place. Cutaneous erysipelas rarely suppurates, but may do so. The fever is remittent, and usually terminates in four or five days by crisis.

In strong subjects the symptoms are usually slight. In the old, debilitated, or alcoholic the symptoms are typhoid, delirium comes on, and death is apt to occur. Possible complications are meningitis, pneumonia, septicæmia, endocarditis, and albuminuria. Erysipelas neonatorum is generally fatal.

Treatment.—Isolate the patient and asepticize any wound. Cases of cutaneous erysipelas tend to get well without treatment. If a person is debilitated, stimulate freely. Tincture of chloride of iron and quinine are usually administered. Nutritious food is important. For sleeplessness or delirium use chloral or the bromides; for high temperature, cold sponging and antipyretics. To prevent spreading, inject the healthy skin near the blush with a 2 per cent. carbolic solution or with gr. $\frac{1}{16}$ of corrosive sublimate. Locally, paint the inflamed area with equal parts of iodine and alcohol and apply lead-water and laudanum. If an extremity be involved, bandage it. Another good treatment is a 50 per cent. ichthyol ointment with lanolin. Some use iced-water cloths. Others apply borated talc or salicylated starch. Ringer advised painting every three hours with a mixture composed of gr. xxx of tannic acid, gr. xxx of camphor, and ʒiv of ether. Da Costa recommends pilocarpine.

Cellulo-cutaneous or **phlegmonous erysipelas** is characterized by high temperature (104°–106°), the rapid onset of grave prostration, irregular chills, sweats, and a strong tendency to delirium. The parts are not so red as in the pre-

vious form, but the tumefaction is vastly greater; it is branny, comes on early and with exceeding rapidity, inducing a high degree of tension and frequently producing sloughing or even cutaneous gangrene. The lymphatic glands are swollen, but the inflamed vessels are hidden by the swelling. In most cases suppuration occurs, and when this happens the parts become boggy. When the disease abates sloughs form, which leave ulcers upon being thrown off. In bad cases muscles, vessels, tendons, and fascia may slough away. The commonest complications are suppression of urine, broncho-pneumonia, congestion and œdema of the lungs, meningitis, and acute pleurisy.

Treatment.—At once asepticize and drain any existing wound; apply iodine and blue ointment or ichthyol or lead-water and laudanum to the inflamed area, and if a limb is involved use a roller-bandage and a sling. Open the bowels with calomel and salines; order quinine, iron, stimulants, and nourishing diet. If suppuration occurs, make many incisions near together, each cut being 2 or 3 inches long. Spray out by means of hydrogen peroxide in an atomizer, and then wash with corrosive-sublimate solution (1 : 1000). Drain by means of iodoform gauze in strips. Excise spots of gangrene. Dress with many layers of wet gauze, which is to be enveloped in a rubber dam after application, or with dry gauze and iodoform. If sloughs form, cut them partly away and employ antiseptic poultices. Apply a bandage to an extremity which is attacked by this form of erysipelas. Change dressings often. When granulations begin to form, treat as a healing wound.

Cellulitis.—In cellulitis redness of the skin is not very pronounced and is late in appearing, following swelling, and not preceding it. It is essentially the same condition as phlegmonous erysipelas. It is often mild in degree. Its spread is heralded by red lines of lymphangitis, swelling of

glands, and fever. In slight cases the lymphatics may dispose of the poison and suppuration fail to occur.

Treatment.—The treatment is the same as that for phlegmonous erysipelas.

XI. TETANUS, OR LOCKJAW.

Tetanus is an infectious spasmodic disease invariably preceded by some injury. The wound may have been so slight as to have attracted no attention, or it may have been inflicted upon the alimentary canal by a fish-bone or other foreign body. Idiopathic tetanus is either not tetanus at all or is a term expressive of the fact that we have not found an injury which did exist. This disease is commonest after punctured or lacerated wounds of the hands or feet, and before it appears a wound is apt to suppurate or slough; but in some instances the wound is found soundly healed. Tetanus may appear twenty-four hours after an accident, but it may not arise until several weeks have elapsed. It prevails more in certain localities than in others. Colored people are very susceptible, and it may exist epidemically. Tetanus is due to infection by a bacillus (first described by Nicolaier) whose toxic products, absorbed from the infected area, poison the nervous system precisely as would dosing with strychnine. This bacillus is found particularly in garden-soil, in the dust of walls, walks, and cellars, in street-dirt, and in the refuse of stables.

Symptoms.—*Acute tetanus* usually begins within nine days of an accident. First the neck feels stiff, the patient thinking he has taken cold, and next the jaws also become stiff. The neck becomes like an iron bar, and the jaws become as rigid as steel. The muscles of deglutition become rigid on attempts at swallowing. The muscles of the back, legs, and abdomen are thrown into tonic spasm, but the arms rarely suffer. Spasm of the face-muscles causes the *risus*

sardonicus, or sardonic smile (contraction particularly of the *musculus sardonicus* of Santorini). The contraction of the muscles of the back is often so powerful as to bend the patient back like a bow and allow him to rest only on his occiput and heels. This condition is known as "opisthotonos." If he is bent forward so that the face is drawn to the legs, it is called "emprosthotonos." If his body is curved sideways, it is designated "pleurosthotonos." An upright position is "orthotonos."

The state is one of widely-diffused tonic spasm, aggravated frequently by clonic spasms arising from peripheral irritations. These irritations may be draughts, sounds, lights, shaking of the bed, attempts at swallowing, contact of the bed-clothing, the presence of urine in the bladder or of feces in the rectum, or various visceral actions. The agonizing "girdle-pain" so often met with means spasm of the diaphragm. Each clonic spasm causes a hideous scream by the contraction of the chest forcing air through a contracted glottis. Constipation is persistent; retention of urine is the rule. The mind is entirely clear—one of the worst elements of the disease. Swallowing is absolutely impossible. The temperature may be normal, but it is usually a little elevated. Hyperpyrexia sometimes occurs (108°–110°), and the temperature may even ascend for a time after death. Sleep is impossible. Death almost invariably occurs in acute tetanus in two or three days. It may be due to exhaustion or to carbonic-acid narcosis from spasm of the glottis or fixation of the respiratory muscles.

Chronic tetanus comes on late after a wound (from ten days to several weeks). The symptoms are not so severe; the muscular spasm is widespread, but it may not be persistent, intervals of relaxation permitting sleep and the taking of food. It may last some weeks, and not infrequently the disease can be cured. *Trismus* is a mild form of tetanus,

the contractions being limited to the face and jaw. *Trismus neonatorum* or *trismus nascentium*, which is lockjaw in the new-born, is due to infection of the stump of the umbilical cord, and is invariably fatal.

Diagnosis.—Tetanus may be confounded with strychnine-poisoning or with hysteria. Wood's table makes the diagnosis clear.[1]

TETANUS.	HYSTERICAL TETANUS.	STRYCHNINE-POISONING.
	Commences with blindness and weakness.	Begins with exhilaration and restlessness, the special senses being usually much sharpened. Dimness of vision may in some cases be manifested later, after the development of other symptoms, but even then it is rare.
Muscular symptoms usually commence with pain and stiffness in the back of the neck, sometimes with slight muscular twitchings; come on gradually. Jaw one of the earliest parts affected; rigidly and persistently set.	Muscular symptoms commence with rigidity of the neck which creeps over the body, affecting the extremities last. Jaws rigidly set before a convulsion, and remain so between the paroxysms.	Muscular symptoms develop very rapidly, commencing in the extremities, or the convulsion when the dose is large seizes the whole body simultaneously. Jaw the last part of the body to be affected; its muscles relax first, and even when, during a severe convulsion, it is set, it drops as soon as the latter ceases.
Persistent muscular rigidity very generally, with a greater or less degree of permanent opisthotonos, emprosthotonos, pleurosthotonos, or orthotonos.	Persistent opisthotonos and intense rigidity between the convulsions and after the convulsions have ceased, the opisthotonos and intense rigidity lasting for hours.	Muscular relaxation (rarely a slight rigidity) between the convulsions, the patient being exhausted and sweating. If recovery occurs, the convulsions gradually cease, leaving merely muscular soreness, and sometimes stiffness like that felt after violent exercise.
Consciousness preserved until near death, as in strychnine-poisoning.	Consciousness lost as the second convulsion comes on, and lost with every other convulsion, the disturbance of consciousness and motility being simultaneous.	Consciousness always preserved during convulsions, except when the latter become so intense that death is imminent from suffocation, in which case sometimes the patient becomes insensible from asphyxia, which comes on during the latter part of a convulsion and is almost a certain precursor of death.

[1] *Nervous Diseases*, by Prof. H. C. Wood.

Tetanus.	Hysterical Tetanus.	Strychnine-poisoning.
Draughts, loud noises, etc. produce convulsions, as in strychnine-poisoning; may complain bitterly of pain.	Crying-spells alternating with convulsions.	The "slightest breath of air" produces convulsion. Patient may scream with pain or may express great apprehensions, but "crying-spells" would appear to be impossible.
Eyes open and rigidly fixed during the convulsion.	Eyes closed.	Eyes stretched wide open.
	Partial spasm in the leg, producing in Wood's cases crossing of the feet and inversion of the toes. If all the muscles were involved eversion would occur, as the muscles of eversion are the stronger.	Legs stiffly extended with feet everted, as the spasms affect all the muscles of the leg.

Treatment.—Far better than even to treat tetanus well is to prevent it. Careful antisepsis will banish it as thoroughly as it has banished septicæmia. Every wound must be disinfected with the most scrupulous care. Every punctured wound is to be incised to its depth and thoroughly cleaned and drained. Puerperal tetanus is prevented by antiseptic midwifery, and tetanus neonatorum is obviated by the antiseptic treatment of the stump of the cord. When tetanus exists, always look for a wound, and if one is found, open it, cut away sloughs, wash with peroxide of hydrogen and corrosive sublimate, swab it out with bromine, and secure drainage by packing it with iodoform gauze.

Isolate the patient, as the disease is infective; keep him in a darkened, well-ventilated, and quiet apartment, so as to exclude as far as possible peripheral irritation. Watch out for retention of urine, and use the catheter if it occurs. Secure movements of the bowels by salines, castor oil, croton oil, or enemas. Give plenty of concentrated liquid food, and stimulate freely with alcohol. If swallowing causes convulsions, give an inhalation of nitrite of amyl before an attempt is made to swallow. If this treatment fails, partially anæs-

thetize the patient and feed him through a pharyngeal tube passed through the nose. Large doses of the bromide of potassium or of this drug with chloral give the best results. Other drugs that have been used with some success are gelsemium, morphia, curare, injections and fomentations of tobacco, physostigma, anæsthetics, cocaine, and cannabis indica. An ice-bag to the spine somewhat relieves the girdle-pain. Hot baths have been advised.

Yandell says, in summing up Cowling's report on tetanus:[1] "Recoveries from traumatic tetanus have been usually in cases in which the disease occurs subsequent to nine days after the injury. When the symptoms last fourteen days, recovery is the rule, apparently independent of treatment. The true test of a remedy is its influence on the history of the disease. Does it cure cases in which the disease has set in previous to the ninth day? Does it fail in cases whose duration exceeds fourteen days? No agent tried by these tests has yet established its claims as a true remedy for tetanus."[2]

It is now claimed by some observers that we have a remedy which fulfils the requirements of Yandell in the tetanus antitoxine of Tizzoni and Kitasato. To prepare this antitoxine animals are rendered immune to tetanus by inoculations with mitigated cultivations of the microbe; the blood-serum is treated with alcohol and dried in a vacuum. This is used hypodermatically in doses of from 15 to 25 centigrammes. Cures seem to have followed its use, and if it can be obtained it is our duty to try it in acute tetanus.

XII. TUBERCULOSIS AND SCROFULA.

Tuberculosis is an infective disease due to the deposition and multiplication of the bacilli of tubercle in the tissues

[1] *American Practitioner*, Sept., 1870.

[2] Quoted by Hammond in his *Diseases of the Nervous System*.

of the body. It is characterized either by the formation of tubercles or by a widespread infiltration, both of these conditions tending toward caseation, sclerosis, or ulceration. A tubercular lesion may undergo calcification.

Bacillus of Tubercle.—A tubercle is an infective granuloma, appearing to the unaided vision as a semi-transparent gray mass the size of a mustard-seed. The microscope shows that a gray tubercle consists of a number of cell-clusters, each cluster constituting a primitive tubercle. A typical primitive tubercle shows a centre consisting of one or of several polynucleated giant-cells surrounded by a zone of epithelioid cells which are surrounded by an area of leucocytes. When the bacillus obtains a lodgment the fixed connective-tissue cells multiply by karyokinesis, forming a mass of nucleated polygonal or round cells, called "epithelioid" from their resemblance to epithelial cells, and at the same time the blood-supply of the growth is limited by occlusion of surrounding vessels through multiplication of their endothelial coats. Some of these epithelioid cells proliferate, and others attempt to, but fail for want of blood-supply. Those that fail succeed only in dividing their nuclei and enormously increasing their bulk (giant-cells). Giant-cells, which also form by a coalescence of epithelioid cells, are not always present. The presence of this mass of cells causes surrounding inflammation and the exudation of white blood-cells (Fig. 30).


FIG. 30.—Synovial Membrane, showing giant-cells (Bowlby).

The bacillus, when found, exists in the epithelioid cells, and sometimes in the giant-cells; it may not be found, having once existed, but having been subsequently destroyed. It is often

overlooked. In a lesion of active tubercle, even if the bacillus be not found, injection of the matter into a guinea-pig will produce lesions in which it can be demonstrated. A tubercle may caseate—a process that is destructive and dangerous to the organism. Caseation is due to a coagulation necrosis arising from direct microbic action upon a cellular area which contains no blood-vessels, and the nutrition is cut off by obliteration of surrounding vessels. This process starts at the centre, and the entire tubercle becomes converted into a soft yellowish-gray mass. Caseation forms cheesy masses which may soften into tuberculous pus, may calcify, and may become encapsuled by fibroid tissue.

A tubercle may undergo sclerosis, which is an attempt on the part of Nature to heal and repair. Coagulation necrosis occurs in the centre of the tubercle; "hyaline transformation proceeds, together with a great increase in the fibroid elements, so that the tubercle is converted into a firm, hard structure" (Osler). Infiltrated tubercle is due to the running together of many minute infective foci or to widespread infiltration without any foci. Infiltrated tubercle tends strongly to caseate.

The bacillus of tubercle, discovered by Koch, is a little rod with a length equal to about half the diameter of a red blood-corpuscle. It can be stained by aniline, and this stain is not removable by acids (it being the only bacillus except leprosy which acts in this way.) In its growth the tubercle bacillus forms ptomaïnes, toxalbumins, and an antitoxine. These bacilli exist in all active lesions: the more active the process the greater is their number. They may be widely distributed, but are rarely identified in the blood. They exist in enormous numbers in phthisical sputum, but are not found in the breath of consumptives. Their great medium of distribution is dried sputum mixed with dust. They are

found in the milk of tuberculous cows, and sometimes in the meat of diseased animals.

Infection may be due to hereditary transmission. Congenital tuberculosis is occasionally, though rarely, seen. Tuberculosis is apt to appear in young children. Some think this is due to infection from without upon tissues whose resistance is lowered by hereditary predisposition; others think it is due to a tardy development of the germs transmitted by heredity. That the disease may be present in a latent form is shown by the experiment in which the viscera of the fœtus of a consumptive mother showed no tubercles, but produced the disease in guinea-pigs when inoculated.[1] Tuberculosis may arise by inoculation, inoculation tuberculosis being seen in leather-workers and in those who dissect tuberculous bodies (butchers and doctors are liable to anatomical tubercle). Osler mentions as other causes of inoculation the bite of a tuberculous patient, the washing of infected garments, and circumcision in which suction is employed. Infection through the air is very common. The bacteria of the dried sputum adhere to particles of dust and are carried into the lungs. Infection by meat, milk, and other foods may arise by this dust settling upon them in quantity. Commonly, however, it is due to disease of the animals. Milk is a common vehicle of contagion, and it can be infected even when an ulcerated udder does not exist.

Infection is favored by hereditary predisposition—that is to say, by hereditary tissue-weakness, which, by maintaining a lowered momentum of nutritive processes, lessens the normal resistance to infection. Two types of these predisposed persons are mentioned: (1) the sanguine type of scrofula, or those with oval faces, clear skin, large blue eyes, long lashes, a nervous manner, precocious minds, but little fat, and with long slender bones, these children being often graceful and

[1] Quoted by Osler from Birch-Hirschfeld.

beautiful; and (2) those with stolid countenances, thick lips and noses, thick muddy skin, dark coarse hair, swollen necks, heavy bones, clumsy gait, and ungainly figure. The latter type is the phlegmatic form of scrofula.

There is no doubt that an inflammatory area in a person can become infected when a sound area would escape, the process of phagocytosis being in this spot limited in power, and the organisms, which are destroyed by healthy cell-activities, are victorious when those activities are diminished. Catarrhal inflammations of the air-passages favor phthisis, and traumatism is not unusually followed by a development of tubercle. Lowered health, impure air, and bad food all favor the development of tubercle. Any tuberculous process tends to spread locally and to produce inflammation. A tubercular area is always a danger to the system; from this as a focus dissemination may occur, tuberculous lesions appearing in a distant part or general tuberculosis setting in. Tuberculous pus is not pus. True pus means a secondary infection (see *Cold Abscess*, p. 100).

Scrofula is not a disease. It is a condition of tissues in which low resisting power makes them hospitable hosts to invading bacilli of tubercle. Some observers teach that scrofula is tuberculosis of bones, glands, and joints; others teach that it is latent tuberculosis until some cause lights it into activity; while still others say that it is a tendency rather than a disease. It is certain that some lesions of scrofula are not tuberculous (eczema capitis, facial eczema, corneal ulcers, granular lids, and chronic catarrhal inflammations), and that they result from ill-health, poor nutrition, bad air, and improper diet. A person who is recognized as of a scrofulous type may never develop tuberculous lesions. It is unquestionable, however, that strumous subjects are peculiarly apt to develop true tuberculous lesions. These lesions often appear after a tissue or an organ has become

the seat of a primary non-tubercular inflammation; the bacilli, which could not live in the non-inflamed tissue, thrive in the inflamed tissue. Scrofula is generally of congenital origin, one or both parents being tuberculous, scrofulous, or in ill-health; it may, however, be acquired as a result of poor food, bad air, crowding, and general lack of sanitation. The scrofulous are very prone to develop tuberculous lesions of bones, joints, and lymphatic glands.

Tuberculous Abscess.—For description of tuberculous abscess, see page 97.

Tuberculosis of the Skin.—*Lupus* begins before the age of twenty-five, most usually upon the face, especially the nose. Three forms are recognized: (1) *lupus vulgaris*, in which nodules appear that after a time ulcerate and then cicatrize; (2) *lupus exedens*, in which ulceration is very great; and (3) *lupus hypertrophicus*, in which a very great amount of embryonic tissue is produced (large nodules or tubercles). Lupus may appear as a pimple, as a group of pimples, or as nodules of a larger size. The ulcer arises from desquamation, and is surrounded by inflammatory products which, by progressively breaking down, add to its size. The ulcer is often crusted over; it may be progressing at one point and healing at another; and it is slow in advancing, but often proves hideously destructive. The scars left by its healing are apt to break down. Clinically it is separated from a rodent ulcer by the absence of a hard base (W. Joseph Hearn).

Anatomical tubercle, the *verruca necrogenica* of Wilks, is due to local inoculation with tuberculous matter. It is seen in surgeons, the makers of post-mortems, leather-workers, and butchers, usually upon the backs of the hands and fingers. It consists of a red mass of granulation tissue having the appearance of a group of inflamed warts. Pustules often form.

Scrofulodermata or **scrofulous gummata** are chronic

skin-inflammations from granulation tissue which breaks down to form small abscesses or sinuses.

Tuberculosis of Subcutaneous Connective Tissue.—In this form of tuberculosis nodules of granulation tissue form and break down (tuberculous abscesses). In the deeper tissues these abscesses are usually associated with bone-, joint-, or lymphatic-gland disease. A large abscess is called "cold" (see *Cold Abscess*, p. 100).

Tuberculosis of the Alimentary Canal.—A tuberculous ulcer of the lip occasionally occurs, and is usually mistaken for a cancer or a chancre. A tuberculous ulcer of the tongue is commonly associated with other foci of disease. It is separated from cancer by the absence of glandular enlargements, and from syphilitic processes by the therapeutic test. Confirmation of the diagnosis is obtained by cultivations and inoculations. Tubercle may affect the pharynx, palate, tonsils, and very rarely the stomach.

Intestinal tuberculosis ordinarily follows pulmonary tubercle, but it may arise in the mucous membrane of the bowel or result from tuberculous peritonitis. Intestinal tuberculosis may cause diarrhœa and fever, may resemble appendicitis, and may cause abscess and perforation. Fistula in ano is very often tuberculous, and when it is the lungs are almost always involved, the pulmonary lesion being primary.

Tuberculosis of the liver causes cold abscess and scirrhosis. Tubercle may affect the kidneys, bladder, ureters, Fallopian tubes, prostate, urethra, seminal vesicles, ovaries, and uterus. Tuberculous testicle is not rare. Tuberculous orchitis affects one testicle at first, but the other usually becomes involved. It starts in the epididymis as a painless nodule. As the vaginal tunic and testicle become involved a hydrocele forms. The tuberculous mass softens, becomes adherent to the scrotum, and bursts. The cord is always more or less involved.

Peritoneal tuberculosis may be primary, may be part of a diffused process, or may follow intestinal tubercle. The germ may have entered by the Fallopian tube. It causes usually ascites, tympany, and tumor-like formations composed of adherent bunches of bowel or omentum or distended mesenteric glands. Tubercles may attack the pleura or pericardium.

Tuberculosis of the brain induces meningitis and hydrocephalus.

Tuberculous disease of the joints is called "white swelling" and pulpy degeneration of the synovial membrane. It may begin in the synovial membrane, but it usually starts in the head of a bone, dry caries resulting, necrosis ensuing, or an abscess forming which breaks into the joint. In the knee-joint the disease begins as a tuberculous synovitis, in the hip-joint as a tuberculous osteitis of the head of the bone.

Tuberculosis of lymphatic glands is known as "tuberculous adenitis." It is the most typical lesion of scrofula. The common antecedent of a tuberculous adenitis of the neck is slight glandular enlargement as a result of catarrhal inflammation of the mucous membrane of the mouth. A man not of the scrofulous type can acquire tuberculosis of the glands, but adenitis is unquestionably of much greater frequency in the scrofulous. Tuberculous glands may get well and will often calcify. After healing they may break down and soften (residual abscess). They very frequently suppurate. Though at first a local disease, inflamed glands may be foci of infection, and may poison distant organs or the entire system. Glandular enlargement is in rare instances widely diffused, but it is far more commonly localized. Enlargement of the cervical glands is most common. Enlargement of the mesenteric glands causes tabes mesenterica.

Cervical lymphadenitis may be confused with lymphadenoma. The former, as a rule, first appears in the sub-

maxillary triangle, the latter in the occipital or inferior carotid triangles. Tuberculous glands weld together, they are apt to remain localized, and they tend to suppurate. They may be accompanied by other tuberculous manifestations. Lymphadenoma from the start affects many glands in several regions, shows no tendency to suppurate, and is accompanied by great debility and anæmia. Malignant gland-tumors infiltrate adjacent glands and other structures, binding skin, muscles, and glands into one firm mass.

Diagnosis.—The diagnosis may be determined by purely clinical facts. It may require the use of the microscope, cultivation experiments, or inoculations. In a suspected tuberculous lesion remove a portion of the tissue if it be accessible (by Mixter's canula) and make sections, stains, and cultivations. If no bacilli are found, inoculate a guinea-pig with the suspected material. If it be tubercular, the pig will have miliary tuberculosis in a few weeks.

Prognosis.—The prognosis varies with age, sex, and the situation of the lesion. Prognosis is best in children, and is better in males than in females. Tuberculosis of the skin gives a fair prognosis. Tuberculous adenitis is often cured. Any tuberculous lesion is, however, a menace to the organism, and tends strongly toward recurrence.

Treatment.—Surgically, remove infected areas which are accessible. Never remove only part of a focus. Incomplete operations are apt to be followed by diffuse tuberculosis. Iodoform used locally upon or in tuberculous areas is of great value. Tuberculous glands before breaking down should be rubbed with ichthyol and lanolin or with mercurial ointment. When they break down they should be removed or opened, curetted, and packed. The rule must be to completely dissect out lymphatic glands which fail to quickly respond to treatment. Climate is of very great importance. Osler sums up climatic necessities as "pure atmosphere, equable tem-

perature, and maximum amount of sunshine." Open-air life is imperative. The patient must have a well-ventilated sleeping-room, and his house should be free from dampness. Nourishing diet is essential. To gain in weight is a constant aim. Give meat, milk, and cod-liver oil, which can be administered in capsules. The oil is poorly borne in hot weather, during which it should be discontinued. Advancing doses of creosote, arsenic, quinine, and stimulants have their uses.

Koch's Tuberculin.—The specific treatment by Koch's tuberculin or paratoloid has excited widespread interest. It has not fulfilled the expectations which many entertained, but does benefit some cases, notably lupus. The trouble with Koch's tuberculin is that it often causes fever and inflammation to a dangerous degree. In some cases, as Virchow showed, it produces acute miliary tuberculosis. Koch's lymph is a glycerin extract of a culture of tubercle bacilli, and the usual dose is 1 milligramme, given hypodermatically into the back by Koch's pistonless syringe. After it has been used for a time the dose may be increased to 10 milligrammes, or even much more. Bergmann gave 1 gram. Koch's lymph causes inflammation and necrosis of tuberculous tissue by the action of certain antitoxines. Many cases it improves. Some cases it apparently cures, but the disease is apt to return. In pulmonary tubercle it must not be given if there be much fever or extensive consolidation. Cheyne used tuberculin by giving two or three doses a day and increasing the dose. It is best to associate other treatment with the lymph.

Hunter of London declares that Koch's lymph contains one principle which causes fever, another which causes inflammation, and a third which produces atrophy of tuberculous foci without either fever or inflammation. This third desirable element he believes he has isolated in what is called a "derivative of tuberculin," a modified lymph. Some

remarkable results have followed the use of this material; its administration seems entirely safe, and it should thoroughly and carefully be tried to ascertain its true rank as a remedy.

XIII. RICKETS.

Rickets is a constitutional disease arising during the early years of life (the first two or three) as a result of insufficient or of improper diet and bad hygienic surroundings. A deficiency of fat and phosphate in the food or the use of a diet which, by inducing gastro-intestinal catarrh, prevents assimilation, causes rickets. The disease is never congenital, the so-called "congenital rickets" being sporadic cretinism (Bowlby). Figure 4 (Pl. 2) shows marasmic rickets.

Evidences of Rickets.—The condition is one of general ill-health; the child is ill-nourished, pallid, flabby; it has attacks of diarrhœa and a tumid belly; it is disinclined for exertion and has a capricious appetite; it is liable to night-sweats and night-terrors; enlarged glands are often noted, the teeth appear behind time, and the fontanelles close late. The long bones become much curved, the upper part of the chest sinks in, curvature of the spine appears, the head is large and the forehead bulges, and the pelvis is distorted. Swelling appears in the articular heads of long bones, beside the epiphyseal cartilages, and in the sternal end of the ribs, forming in the latter case rhachitic beads. The lesions of rickets are due to an imperfect ossification of the animal matter which is prepared for bone-formation, and consequently to softening of the bones which causes them to bend. The swellings at the articular heads are due to pressure forcing out the soft bone into rings. Rhachitic children rarely grow to a full size, and the disease is responsible for many dwarfs. Most cases recover without deformity, but the time lost during the period when active development

should have gone on cannot be made up, and some slight deficiency is sure to remain.

Treatment.—The treatment consists in open air, sunshine, salt-water baths, sea-air, fresh food (milk, cream, and meat-juice), cod-liver oil especially, syrup of the iodide of iron, arsenic, and some form of phosphorus.

XIV. CONTUSIONS AND WOUNDS.

Contusions.—A contusion or bruise is a subcutaneous laceration, the skin above it being uninjured (as in the abdomen) or damaged with a surface-breach (as in a part overlying bone), blood being effused. If a large vessel is damaged, the hemorrhage is large. An *ecchymosis* is diffuse hemorrhage over a large area; a *hematoma* is a blood-tumor or a circumscribed hemorrhage. In a diffuse hemorrhage the coagulation of fibrin induces induration; the serum and leucocytes are absorbed; the red blood-cells disintegrate and the coloring matter is widely diffused (suggillation); and hæmoglobin is changed into hæmatoidin, which crystallizes. In union with these chemical changes, color-changes ensue, the part being at first red and then becoming purple, black, green, lemon, and citron. A hæmatoma acts as an irritant, inflammation ensues around it, and it is encapsuled by embryonic tissue, which, by organizing into fibrous tissue, forms a blood-cyst and gradually absorbs the fluid blood, the cyst-contents becoming thicker and thicker. A fibrous scar may remain. If serum is not absorbed, hæmatoidin forms and the fluid becomes clear. A hæmatoma may suppurate, an abscess forming.

Symptoms.—The symptoms are heat, tenderness, swelling, and numbness followed by pain. Discoloration appears quickly in superficial contusions, but days after in deep ones; shock and loss of function are present after severe contusions.

Treatment.—Obtain reaction from the shock. Local treatment consists of rest, elevation, and compression to arrest bleeding, antagonize inflammation, and control swelling. Cold is useful early in a case, but it is not suited to severe contusions or to contusions in the debilitated or aged, as in such cases it may cause gangrene. Lead-water and laudanum and iodine may be used. In very severe contusions employ heat and stimulation. When inflammation is subsiding after a contusion, massage and ichthyol should be ordered. A contusion should never be opened unless hemorrhage continues, infection takes place, or a lump remains for some weeks. For persistent bleeding freely lay open the contusion, turn out clots, ligate vessels, irrigate with corrosive-sublimate solution, insert a tube, and close. If gangrene is feared, use iodine locally, and if a slough forms, employ antiseptic fomentations. Constitutional treatment for contusion is the same as that for inflammation.

Wounds.—A wound is a breach of surface continuity by a sudden and violent mechanical force. Wounds are divided into open and subcutaneous, septic and aseptic, contused, incised, lacerated, punctured, gunshot, and poisoned.

The local phenomena of wounds are pain, hemorrhage, loss of function, and gaping or retraction of edges.

Pain is due to the injury of nerves, and it varies according to the situation and to the nature of the injury. It is influenced by temperament, excitement, and preoccupation. It may not be felt at all at the time of the injury. At first it is usually acute, becoming later dull and aching. In an aseptic wound the pain is slight, but in an infected wound it is severe.

Hemorrhage varies with the state of the system, the vascularity of the part, and the variety of injury.

Loss of Function.—Depends on the situation and extent of the injury.

Gaping or Retraction of Edges.—Due to tissue-elasticity.

The constitutional condition is that of *shock*, which is a sudden depression of the vital powers arising from an injury or a profound emotion acting on the nerve-centres and inducing vaso-motor paresis, the blood accumulating in the abdominal vessels. It may be slight and transient, it may be severe and prolonged, and it may even produce almost instant death. It is more severe in men than in women, in the nervous and sanguine than in the lymphatic, in those inured to suffering than in those who are strangers to illness. Injury of the abdomen produces great shock, and so does damage to the viscera, the urethra, and the testicles. Cerebral concussion is a form of shock plus other conditions. Sudden and profuse hemorrhage causes shock; so, occasionally, does anæsthetization.

Symptoms.—The symptoms are a temperature much below normal; weak, rapid, and compressible pulse; cold, clammy, or profusely-perspiring skin; shallow respiration; a tendency to urinary suppression; consciousness is usually maintained, but there is an absence of mental originating power, the injured person answering when spoken to, but volunteering no statements and lying with partly-closed lids in any position in which he may have been placed. If delirium arises, the condition is very grave (delirious shock). Pain is slightly or not at all appreciated. Vomiting may, as in concussion, presage reaction. Vomiting after a considerable time in shock is regurgitation, and is a bad omen.

Diagnosis.—Concealed hemorrhage is hard to separate from shock. It produces impairment of vision (retinal anæmia), irregular tossing, frequent yawning, nausea, and sometimes convulsions. In shock the hæmoglobin is unaltered; in hemorrhage it is enormously reduced (Hare and Martin). In hemorrhage recurrent attacks of syncope are met with. Shock and hemorrhage are often associated. The

essential characteristic of shock is sudden onset, which separates it from exhaustion.

Treatment.—In treating shock from a wound, lower the head, apply hot bottles and hot blankets, and give hypodermatic injections of ether, brandy, strychnine, digitalis, or atropia. A turpentine enema is useful. Hot coffee or other hot fluids should be given by the mouth and rectum, mustard be placed over the heart, spine, and shins, and the hypodermoclysis of salines be practised. If shock comes on during operation, the proceedings must be hurried or even be stopped. Should we operate during shock? Clearly, no, except for the purpose of arresting hemorrhage. Do not, for instance, perform an amputation in shock, but arrest hemorrhage, asepticize, and bring about reaction before operating.

Fat-embolism.—(See *Embolism*, p. 124.)

Fever.—(See *Fevers.*)

Treatment of Wounds.—The rules for treating wounds are—(1) arrest hemorrhage; (2) bring about reaction; (3) remove foreign bodies; (4) asepticize; (5) drain, coaptate the edges, and dress; and (6) secure rest to the part and combat inflammation. Constitutionally, allay pain, secure sleep, keep up the nutrition, and treat inflammatory conditions.

Arrest of Hemorrhage.—To arrest hemorrhage the bleeding point must be controlled by digital pressure until ready to be grasped with forceps; it is then caught up and tied with catgut or aseptic silk. Slight hemorrhage stops spontaneously on exposure to air, and moderate hemorrhage ceases after the vessels are clamped for a time; an injured vessel of some size must be ligated, even if it has ceased to bleed. Capillary oozing is checked by hot-water compresses. If a large artery is divided in a limb, apply a tourniquet before ligating (see *Wounds of Vessels*).

Bringing About of Reaction.—(See *Shock.*)

Removal of Foreign Bodies.—Remove all foreign bodies

visible to the eye (splinters, bits of glass, portions of clothing, gun-wadding, grains of dirt, etc.) with forceps and a stream of corrosive-sublimate solution. In a lacerated or contused wound portions of tissue injured beyond repair should be regarded as foreign bodies and be removed with scissors.

Cleaning the Wound.—To clean the wound scrub the area around it with Johnson's ethereal soap and then with corrosive-sublimate solution (1 : 1000). If the surface is hairy, it must be shaved. The wound must be well washed out with an antiseptic solution, thus getting rid of blood-clots which would serve to separate the edges and favor infection.

Drainage, Closure, and Dressing.—Superficial wounds require no special drain, as some wound-fluid will find exit between the stitches and the rest will be absorbed. A large or deep wound requires free drainage for at least twenty-four hours by means of a tube, strands of horse-hair, silk, or catgut, or bits of iodoform gauze. An infected wound must invariably be drained. Good drainage almost compensates for imperfect antisepsis. If capillary drains be employed, apply a moist dressing. Divided nerves and tendons must be sutured. Close the edges with silk sutures or silkworm-gut if the wound is deep and tension is inevitable. Catgut is used for superficial wounds and for those where tension is slight. The interrupted suture is, as a rule, the best. If the wound is infected, dress with antiseptic gauze; or with either aseptic or antiseptic gauze if it is not infected. Cover the gauze with a rubber dam to diffuse the fluids. Change the dressings in twenty-four hours, or sooner if they become soaked with discharge. After this, in an aseptic wound, the dressing need not be changed for days. If pus forms, open the wound at once.

Rest.—Severe wounds require confinement in bed. Bandages, splints, etc. are used to secure rest. The methods of combating inflammation have previously been set forth.

Constitutional Treatment.—Bring about reaction from depression, but prevent undue reaction. Feed the patient well, stimulate him if necessary, and attend to the bowels and bladder. Watch the temperature as the danger-signal, secure sleep, and allay pain. Look out for complications, namely, inflammation, suppuration, gangrene, tetanus, and erysipelas.

Incised Wounds.—An incised wound is a clean *cut* inflicted by an edged instrument. Only a thin film of tissue is so devitalized that it must die. These wounds have a splendid chance of union by first intention.

Symptoms.—The symptoms of incised wounds are sharp pain for a time, followed by smarting, profuse bleeding, and decided retraction of the edges.

Treatment.—The treatment of incised wounds is according to general rules. Do not use styptics, as they cause a repugnant clot, produce irritation, and favor infection.

Lacerated and Contused Wounds.—A *lacerated* wound is a tearing apart of the tissues; a *contused* wound is a crushing and pulpefying of tissues. These two forms are combined. They are irregular, contain masses of partially-detached tissue and blood-clots, and their edges are cold and discolored. Such wounds tend to necrosis.

Symptoms.—The symptoms are excessive shock, slight hemorrhage, and only a moderately dull pain. Reactionary and secondary hemorrhages are common. Infection is liable to occur, and more or less sloughing is bound to ensue.

Treatment.—Any damaged vessel, whether it bleeds or not, must be tied, the devitalized tissues cut away, and foreign bodies removed. Asepticize with great care and secure thorough drainage, making very usually counter-openings. In dressing, put iodoform in the wound and close it partially. Watch for bleeding during reaction. When sloughing begins, use antiseptic fomentations. A *brush-burn*, which is a contused-lacerated wound due to friction, requires the

use of an antiseptic poultice until the slough is cast off. In badly-lacerated wounds and crushes it is often necessary to amputate.

Punctured wounds are wounds made by pointed instruments. A punctured wound is usually deep, it closes partly after withdrawal of the instrument, blood-clot and wound-fluids cannot get exit, and infection is certain if the instrument carries microbes. Large-sized foreign bodies may be driven in or a portion of the instrument may break off. Arrow-wounds are punctured and incised.

Symptoms.—In punctured wounds the pain is rarely severe, but hemorrhage is slight unless a large vessel be wounded. Infection is apt to ensue. Varicose aneurysm may be caused.

Treatment.—In treating punctured wounds incise to the depth of the puncture, stop the hemorrhage, asepticize, and drain. An arrow should never be pulled out, but should be pushed through or cut down to by enlarging the wound.

Gunshot wounds are injuries inflicted by projectiles, such as shot and bullets, driven by explosives. If a bullet just grazes a surface, a friction-burn results; if it enters the tissues, it produces a punctured-contused-lacerated wound; if it strikes the tissue, but fails to enter, it causes a contusion. If a bullet enters a cavity or an organ and does not emerge, it produces a penetrating wound; if it does emerge, it is a perforating wound. Bullets are very apt to carry a foreign body into the tissues (clothing, wadding, etc.). The wound of entrance is round, smooth, and depressed, and is smaller than the ball, because the skin stretches as the bullet strikes it and contracts again after it has passed. The skin around the wound of entrance is discolored by the ball, or, if the discharge took place near the victim, it is blackened by the gunpowder. A wound of entrance larger than the ball means the entrance with the projectile of some foreign body. The wound of

exit, if one exists, is irregular, everted, and larger than the bullet (especially so if a round ball was used). Hemorrhage is slight unless a large vessel is opened, pain varies, and shock is severe. Dense fascia resists a ball strongly, often deflecting it, and is irregularly torn when the missile passes, presenting fringes which interfere with probing and drainage. Tendons are generally pushed away. Vessels are usually pushed aside, but they may be divided. If pushed aside, the damage done them is apt to produce sloughing and secondary hemorrhage or cause an aneurysm to develop.

Diagnosis.—To diagnosticate the extent and nature of a gunshot wound, put the parts in the position they were in when injured; ascertain the direction of the ball's course, the size and nature of the weapon, and its distance away when fired. Examine the clothing to see if any part was carried in. Do not probe without a special indication.

Treatment.—To treat a gunshot wound, bring about reaction. If hemorrhage be severe, take a knife and enlarge the wound, find the bleeding vessel, and secure it. Thoroughly cleanse the wound and adjacent parts before handling. Do not explore for the ball unless sure that it has carried in with it septic foreign bodies, unless its presence interferes with repair, unless it is in or near a vital region (as the brain), or unless it is necessary to determine the position of the ball in order to decide the question of amputation or resection. The best probe is the finger. There may be used Fluhrer's aluminium probe, Nélaton's porcelain probe, the stem of a clay pipe, or a bit of pine wood, the last three of which stain with lead and will indicate whether the hard body is bone or a bullet. Girdner's telephonic probe can be tried if we wish to locate the ball. If any chance of success exists, try to get primary union by antisepsis and rest. This union will usually fail because of infection at the time of the injury and the inevitable necrosis

of the compressed and damaged tissue. In any case use rigid antisepsis and watch for complications. Infection calls for enlargement of the wound and a counter-opening. For removing a ball numerous forceps have been devised.

Resection.—Resection is sometimes demanded for the splintering of a joint.

Amputation is sometimes demanded because of great injury to the soft parts (as by a shell-fragment), the splintering of a bone, injury of a joint, damage to the chief vessels or nerves, or the destruction of a considerable part of a limb. Perform a primary amputation if possible, and make the flaps through tissue that will not slough. In civil practice, with careful antisepsis, more questionable tissue can be admitted into a flap than in military practice, where transportation may be necessary and antisepsis be imperfect or wanting.

Poisoned wounds are those in which a poison is introduced. This poison may be microbic and capable of self-multiplication, or it may be chemical, and hence incapable of multiplication. There are three classes of poisoned wounds:[1] (1) mixed infection, as septic wounds, dissection-wounds, and malignant œdema; (2) chemical poison, such as snake-bites and insect-stings; and (3) microbic infection, such as rabies, glanders, etc.

Septic wounds are those which suppurate or slough. Open septic wounds freely for drainage, curette or cut away hopelessly damaged tissue, wash with peroxide of hydrogen and then with corrosive sublimate, dust in iodoform, and either use a drainage-tube or pack with iodoform gauze. Watch the temperature for evidences of general infection or intoxication. Stimulate and secure good nourishment, rest, and sleep.

Dissection-wounds are simple examples of infected wounds, and they present nothing peculiar except virulence.

[1] *American Text-book of Surgery.*

They affect butchers, cooks, surgeons who cut themselves in operating on a poisoned area, those who make post-mortems, and those who dissect. A dissection-wound inflicted while working on a body injected with chloride of zinc possesses but few elements of danger unless the health of the student is much broken down. Post-mortems are peculiarly dangerous when the subject has died of some septic process. When a wound is inflicted while dissecting, wash it under a strong stream of water, suck it to make the blood run, lay it open if it be a puncture, swab it out with pure carbolic acid, and dress it with iodoform and gauze. If infection shows itself, it must be treated as any other infected wound.

Malignant œdema or **gangrenous emphysema** arises, as a rule, after punctures. It is due to a specific bacillus which produces great œdema, and to secondary infection with putrefactive organisms.

Symptoms.—The symptoms are œdema, the fluid being distinctly bloody, followed by rapidly-diffusing gangrene which is surrounded by a zone of œdematous tissue that crepitates under pressure because it contains gases of putrefaction. The zone of œdema is covered with blebs which contain thin, putrid, reddish matter. The constitutional condition is one of septicæmia. Death occurs, as a rule, in a few days.

Treatment.—To treat malignant œdema, if it affect a limb, amputate at once, high up. If it affect some other part, excise, use the actual cautery, and dress antiseptically. Stimulate very freely.

Stings and Bites of Insects and Reptiles: Stings of Bees and Wasps.—A bee's sting consists of two long lances within a sheath with which a poison-bag is connected. The wound is made first by the sheath, the poison then passes in, and the two lances, moving up and down, deepen the cut. The barbs on the lances make it difficult to rapidly withdraw the sting, which may be broken off and remain in the flesh.

Besides bees, hornets, yellow-jackets, and other wasps produce painful stings. These stings rarely produce any trouble except pain and swelling. In some rare cases a bee-sting is fatal; persons have been stung to death by a great number of these insects.

Symptoms.—If general symptoms ensue, they appear rapidly and consist of great prostration, vomiting, purging, and delirium or unconsciousness. These symptoms may disappear in a short time, or they may end in death from heart-failure. Stings of the mouth may cause œdema of the glottis.

Treatment.—To treat a bee-sting, extract the sting if it be broken off, and apply locally a solution of washing-soda, tincture of arnica, iodine, or lead-water and laudanum. If constitutional symptoms appear, stimulate.

Other Insect-bites and Stings.—The mandibles of a spider are terminated by a movable hook which has an opening for the emission of poison. The bite of large spiders is productive of inflammation, swelling, weakness, and even death. The bite of the poisonous spider of New Zealand produces a large white swelling and great prostration; death may ensue, or the victim may remain in a depressed, enfeebled state for weeks or even for months. The tarantula is a much-dreaded spider. A scorpion has in its tail a sting, and a scorpion's sting produces great prostration, delirium, vomiting, diaphoresis, vertigo, headache, local swelling, and burning pain, followed often by suppuration, or even by gangrene and fever. Centipedes must be of large size to be formidable to man, and the symptoms arising from their stings are usually only local.

Treatment.—Tie a fillet above the bitten point; make a crucial incision, favor bleeding, and swab out the wound with pure carbolic acid or some caustic or antiseptic (if in the wilds, burn with fire or gunpowder); dress antiseptically if possible, and stimulate as constitutional symptoms appear,

slowly loosening the ligature. Chloroform stupes and ipecac poultices are recommended, also puncture with a needle and rubbing in 3 parts of chloral and 1 part of camphor.[1]

Snake-bites.—The poisonous snakes of America comprise the copperheads, water-moccasins, rattlesnakes, and vipers. There is also a poisonous lizard. The symptoms of snake-bite are similar whether it is the bite of an Indian cobra or of an American rattler, and they depend upon the dose of poison introduced. Poison injected into a vein may prove almost instantly fatal. The poison is not absorbed by the sound mucous membranes. It is discharged through the hollow fangs of the reptile by contractions of the muscles of the poison-bag. In most varieties of snakes the teeth lie along the back of the mouth and are only erected when the reptile strikes. The poison contains proteid constituents, globulins, and peptones (Mitchell and Reichert), and probably toxic animal alkaloids (Brieger).

Symptoms.—The symptoms are—pain, soon becoming intense; mottled swelling of the bitten part, which swelling may be enormous, and which is due to œdema and extravasation of blood, and assumes a purpuric discoloration. There may be complete consciousness, or there may be lethargy, stupor, or coma. Some cases present spasms. The general symptoms are those of profound shock, which may present delirium (delirious shock). Death may arise from paralysis of the heart, and may occur in about five hours, but as a rule it is postponed for a number of hours. If death is deferred many hours, profound sepsis comes upon the scene, with glandular enlargement, suppuration, and sometimes gangrene.

Treatment.—Cases of snake-bite must, as a rule, be treated without proper appliances. Prof. Gross related that he had seen an army officer blow off his finger with a pistol the moment it was struck, and thus escape poisoning. For bit-

[1] Bauerjie, in the *Lancet*.

ten fingers or toes this treatment would be wise. In general, the rules are to twist several fillets at different levels above the bite, to excise the bitten area, to suck or cup it if possible, and to cauterize it by a pure acid or by heat. An expedient among hunters is to cauterize by pouring gunpowder on the excised area and applying a spark, or by laying a hot ember on the wound. When a hot iron is available, use it. The fillets are not to be removed suddenly, and they had best be kept on for some time. Remove the highest constricting band first; if no symptoms come on after a time, remove the next, and so on; if symptoms appear, reapply the fillet. The constitutional treatment is expressed in one word: stimulate. Our only hope is in large doses of alcohol, and, if they can be obtained, ammonia, ether, strychnine, or digitalis hypodermatically administered. Morphia can be given for pain. There is no specific for snake-poison. Hypodermatic injections in the area adjacent to the bite of a 1 per cent. solution of the permanganate of potash are commended by some. Halford of Australia praises the intravenous injection of ammonia (10 ♏ of strong ammonia in 20 ♏ of water). If a man is bitten by a large and deadly snake, the surgeon, if one is at hand, should at once amputate well above the bite.[1]

Anthrax (malignant pustule, charbon, wool-sorters' disease, Milzbrand, or splenic fever) is a term used by some as synonymous with carbuncle, but it is not here so employed. Anthrax, when seen among men, is a disease caught in some manner from an animal with splenic fever. It may be caught by working around diseased animals, by handling or tanning their hides, by sorting their hair or wool; it may be conveyed by eating infected meat or by drinking infected milk. Flies may carry the poison.

Forms of Anthrax.—There are two forms of the disease

[1] Charters James Symonds, in *Heath's Dictionary.*

—anthrax carbuncle and anthrax œdema. The *external* form presents a papule with a red base; the papule becomes a vesicle which contains bloody serum; the vesicle bursts and dries, the base of it swells and enlarges, other vesicles appear in circles around it, and there is developed an "anthrax carbuncle" which shows a black or purple elevation with a central depression surrounded by one or more rings of vesicles. Pain is trivial. Lymphatic enlargements occur. In loose connective tissue the lesion may be anthrax œdema, a spreading livid œdema followed by blebs and even by gangrene. The constitutional symptoms may rapidly follow the local lesion, but may be deferred for a week or more. The patient feels depressed, has obscure aches and pains, and is feverish, but usually keeps about for a short period. After a time he is apt to develop rigors, high irregular fever, sweats, acute fugitive pains, diarrhœa, delirium, typhoid exhaustion, dyspnœa, cough, and cyanosis. The local carbuncle of anthrax is distinguished from ordinary carbuncle by the central depression, the adherent eschar, the absence of tenderness, and the absence of suppuration of the first, as contrasted with the elevated centre, the multiple foci of suppuration and sloughing, and the acute pain of the second. Anthrax œdema differs from cellulitis in the absence of all tendency to form pus, and from malignant œdema by the greater tendency of the latter to result in gangrene. If anthrax has a visible lesion and the constitutional symptoms are slight or absent, the chance of cure is good.

Treatment.—If a person is wounded by an object suspected of carrying the infection, cauterize the wound with the hot iron. A malignant pustule should be entirely excised and the wound mopped out with pure carbolic acid, or burnt with the hot iron and afterward dressed with wet bichloride-of-mercury gauze which is covered with an ice-bag. Another plan is to make crucial incisions through the

lesion, to mop out with pure carbolic acid, and to inject around and in the pustule carbolic acid (1 : 10) every six hours until the disease abates or toxic symptoms appear. The adherent eschar is subsequently gotten away by antiseptic poultices. Constitutional treatment is sustaining and stimulating.

Hydrophobia, Rabies, or Lyssa.—Hydrophobia is a spasmodic and paralytic disease due to infection through a wound with the virus from a rabid animal. The animal may be a dog, a cat, a wolf, a fox, or a horse. Roux estimates that about 14 per cent. of the people bitten by mad animals develop the disease. If the bite is on an exposed part, it is far more apt to cause rabies than if the teeth pass through clothing. Hydrophobia is always fatal. The saliva is the usual vehicle of contagion, but other fluids and tissues contain it, especially the brain and cord.

Symptoms.—The period of incubation of hydrophobia is from a few weeks to two years. The initial symptoms are mental depression, anxiety, headache, malaise, and often pain or even congestion in the cicatrix, which symptoms are quickly followed by a general hyperæsthesia, pharyngeal spasms, dyspnœa from laryngeal spasms, and constant attempts to expectorate thick mucus which forms because of congestion of the air-passages. Attempts at swallowing, as well as lights and noises, tend to bring on spasms, hence the fear of liquids (there is spasm from attempts at swallowing or from thinking of the act). The entire body may be thrown into clonic spasms, but there is no tonic spasm. The mind is usually clear, although during the periods of excitement there may be maniacal furor with hallucinations which pass away in the stage of relaxation. The temperature is moderately elevated (101° to 103° or higher). This spasmodic stage lasts from one to three days, and the patient may die during this period from exhaustion or from asphyxia. If he lives through this

period, the convulsions gradually cease, the power of swallowing returns, and the patient succumbs to exhaustion in less than twenty-four hours, or he develops ascending paralysis which soon causes cardiac and respiratory failure.

In hydrophobia death is inevitable. Those cases in which it is alleged that recovery ensued were not true hydrophobia, but hysteria. Wood says that in hysteria, especially among boys, "beast-mimicry" is common, the sufferer snarling like a dog, and in the form known as "spurious hydrophobia," in which there may or may not be convulsion, there is a dread of water, emotional excitement, snarling, and attempts to bite the bystanders (in genuine hydrophobia no attempts are made to bite and no such sounds are uttered as are made by a dog).

Lyssa is separated from lockjaw by the spasms of the larynx and the absence of tonic spasms in the former, as contrasted with the spasms of muscles of mastication and the tonic spasms with clonic exacerbations of lockjaw.

Treatment.—When a person is bitten by a supposed rabid animal, apply constriction above the wound if possible, excise, and burn with the hot iron. Send the patient to a Pasteur institute at once, that he may be given preventive inoculations of an emulsion made from the dried spinal cords of hydrophobic rabbits (attenuated virus). The value of this plan seems definitely established. In the paroxysm the treatment is palliative, and cannot be curative. Keep the patient in a dark, quiet room, relieve thirst by enemata, saturate with morphia, and in the paroxysms anæsthetize.

Glanders, Farcy, or Equinia.—Glanders is an infectious eruptive fever occurring in horses and communicable to man. If the nodules occur in a horse's nares, we call the disease "glanders;" if beneath his skin, it is termed "farcy." This disease is due to the bacillus of Löffler, and is communicated to man through an abraded surface or a mucous

membrane (Osler). The characteristic lesions are infective granulomata which in the nose form ulcers and under the skin develop abscesses.

Acute and Chronic Glanders.—In acute glanders there is septic inflammation at the point of inoculation; nodules form in the nose, and ulcerate; there is profuse nasal discharge; the glands of the neck enlarge; there are fever and an eruption like small-pox on the face and about the joints (Osler). Acute glanders is always fatal. Chronic glanders lasts for months, is rarely diagnosticated, being mistaken for catarrh, and is often recovered from. Diagnosis is made by injecting a guinea-pig with the nasal mucus.

Acute and Chronic Farcy.—Acute farcy appears from a skin-inoculation; it begins as an intense inflammation, from which run out inflamed lymphatics that present nodules or "farcy-buds." Abscesses form. There are joint-pain and the constitutional symptoms of sepsis, but no involvement of the nares. Chronic farcy may last for months. In it nodules occur upon the extremities, which nodules break down into abscesses and eventuate in ulcers resembling those of tuberculosis.

Treatment.—In treating this disease the point of infection is at once to be incised and cauterized. Open the abscesses, swab out with pure carbolic acid, and dress antiseptically. Give stimulants and nourishing diet. Diseased horses ought at once to be killed and their stalls torn out and purified.

Actinomycosis is an infectious disorder characterized by chronic inflammation, and is due to the presence in the tissues of the *actinomyces* or ray-fungus. This disease occurs in cattle (lumpy jaw) and in pigs, and can be transmitted to man, apparently by the food. At the point of inoculation (which is usually about the mouth) arises an infective granuloma, around which inflammation of connective tissue occurs, suppuration eventually taking place.

Symptoms.—The surgeon may see the lesion in the jaw (the enlargement resembling an abscess or sarcoma), on the tongue, and on the skin (resembling cutaneous tuberculosis). Pulmonary actinomycosis presents fever, cough, and wasting, the symptoms being usually one-sided and the fungus being found in the expectoration. Cerebral actinomycosis can occur. Osler says the disease is a chronic pyæmia with the fungus existing in the pus.

Treatment.—The treatment consists in thoroughly extirpating the growth as we would a malignant tumor. Open, curette, and cauterize abscesses and sinuses. Remove dead bone. Iodide of potash has cured cases.

XV. SYPHILIS.

Definition.—Syphilis is a chronic infectious, and sometimes hereditary, constitutional disease. Its first lesion is an infecting area or chancre, which is followed by lymphatic enlargements, eruptions upon the skin and mucous membranes, affections of the appendages of the skin (hair and nails), "chronic inflammation and infiltration of the cellulo-vascular tissue, bones, and periosteum" (White), and, later, often by gummata. This disease is probably due to a microbe, but Lustgarten's bacillus has not been proved to be the one. One fact against its being the cause is its presence in the non-contagious late gummata. White quotes Finger in his assumption that syphilitic fever is due to absorption of ptomaïnes; that the eruptions of skin and mucous membranes in the secondary stage arise from local deposit and multiplication of the virus; that many secondary symptoms result from nutritive derangement caused by tissue-products passing into the circulation; that the virus exists in the body after the cessation of secondary symptoms;

and that it may die out or may awaken into activity, producing " reminders."

During the primary and secondary stages fresh poison cannot infect, and this is true for a time after the disappearance of secondary symptoms. Immunity in the primary stage is due to products absorbed from the infected area. Colles's immunity is that acquired by mothers who have borne syphilitic children, but who themselves show no sign of the disease. Profeta's immunity is the immunity against infection possessed by many healthy children born of syphilitic parents. Tertiary syphilitic lesions are not due to the poison of syphilis, but to tissue-products from the action of that poison. Tertiary syphilis is not transmissible, but it secures immunity.

Transmission of Syphilis.—This disease can be transmitted—(1) by contact with the tissue-elements or virus—*acquired* syphilis; and (2) by hereditary transmission—*hereditary* syphilis. The poison cannot enter through an intact epidermis or epithelial layer, and abrasion or solution of continuity is requisite for infection. Syphilis is usually, but not always, a venereal disease. It may be caught by infection of the genitals during coition, by infection of the tongue or lips in kissing, by smoking poisoned pipes, by drinking out of infected vessels, or by beastly practices. The initial lesion of syphilis may be found on the finger, forehead, eyelid, lip, tongue, cheek, palate, anus, nipple, etc. A person may be a host for syphilis, carry it, give it to another, and yet escape it himself (a surgeon may carry it under his nails, and a woman may lodge it in her vagina). Syphilis can be transmitted by vaccination with human lymph which contains the pus of a syphilitic eruption or the blood of a syphilitic person. Vaccine lymph, even after passage through a person with pox, will not convey syphilis if it is free from blood and the pus of specific lesions; it is not the lymph

that poisons, but some other substance which the lymph may carry.

Syphilitic Stages.—Syphilis was divided by Ricord into three stages: (1) the *primary* stage—chancre and indolent bubo; (2) the *secondary* stage—disease of the upper layer of the skin and mucous membranes; and (3) the *tertiary* stage—affections of connective tissues, bones, fibrous and serous membranes, and parenchymatous organs. This division, which is useful clinically, is still largely employed, but it is not so sharp and distinct as was believed by Ricord; it is only artificial. For instance, ozœna may develop during a secondary eruption, and bone disease may appear early in the case.

Syphilitic Periods.—White divides the pox into the following periods: (1) period of *primary incubation*—the time between exposure and the appearance of the chancre: from ten to ninety days, the average being three weeks; (2) period of *primary symptoms*—chancre and bubo of adjacent lymph-glands; (3) period of *secondary incubation*—the time between the appearance of the chancre and the advent of secondary symptoms: about six weeks as a rule; (4) period of *secondary symptoms*—lasting from one to three years; (5) *intermediate* period—there may be no symptoms or may be light symptoms which are less symmetrical and more general than those of the secondary period: it lasts from two to four years, and ends in recovery or tertiary syphilis; and (6) period of *tertiary symptoms*—indefinite in duration.

Primary Syphilis.—The primary stage comprises the chancre or infecting sore and bubo. A chancre or initial lesion is an infective granuloma resulting from the poison of syphilis. A chancre may be derived from the discharges of another chancre, from the secretion of mucous patches and moist papules, from syphilitic blood, or from the pus or secretion of any secondary lesion. Tertiary lesions cannot cause chancre. It appears at the point of inoculation, and is the first lesion

of the disease. It is not a local lesion from which syphilis springs, but is a local manifestation of an existing constitutional disease, hence excision is entirely useless. If we take the discharge of a chancre and insert it at some indifferent point into the person from whom we took it, a new chancre will not be formed, because he already has syphilis. If we insert it into another person, a chancre is formed. Hence we say that primary syphilis is not auto-inoculable, but is hetero-inoculable.

Initial Lesions.—An initial lesion, hard chancre, or infecting sore never appears until at least ten days after exposure; it may not appear for many weeks, but it usually arises in about three weeks. There are three chief forms of initial lesion: (1) a purple patch exposed by peeling epidermis, without induration and ulceration—a rare form; (2) an indurated area under the epidermis, without ulceration—a very common form; and (3) a round, indurated, cartilaginous area with an elevated edge, which ulcerates, exposing a velvety surface looking like raw ham; it bleeds easily, it rarely suppurates, it does not spread, and the discharge is thin and watery. This is the "Hunterian chancre," which is rarer than the second variety, but commoner than the first, and which ulcerates because of dirt, caustic applications, or friction.

Mixed Infection of Chancre and Chancroid.—A chancre is rarely multiple, but if it is so all the sores appear together as a result of the primary inoculation: they do not follow one another because of auto-infection. A hard sore does not suppurate unless irritated by caustics, friction, or dirt, or unless there be mixed infection with chancroid; its nature is not to suppurate. The hardness may affect only the base and margins of an ulcer or it may affect considerable areas, but it has well-defined margins and feels like cartilage encapsuled, so that it can be picked up in the fingers. This hard-

ness or sclerosis is due to gradual inflammatory exudation into "the tissues at the base of the ulcer and to growth of the nodule" (Von Zeissl). A chancre untreated may last many months. The induration usually disappears soon after the appearance of secondary symptoms. A copper-colored spot remains, and does not disappear until the disease is cured. An induration may again appear before the outburst of some distant lesion.

Von Zeissl says: "If syphilitic contagion is mixed with pus, a chancre begins as a circumscribed area of hyperæmia and swelling, which undergoes ulceration, and does not develop hardness for a period of from ten days to several weeks, and may develop a nodule after the first ulcer has entirely healed." We see this condition when mixed infection occurs, the chancroid poison being quick, and the syphilitic poison being slow, to act. If chancroid poison is deposited some time after the syphilitic poison has been absorbed, the induration may appear in a few days after the chancroid begins. A soft chancre may appear upon an existing syphilitic nodule and may eat out the induration. We must separate a chancre from a chancroid and from ulcerated herpes. A chancroid appears in from two to five days after contagion (always less than ten days); it may be multiple from the start, but, even if beginning as one sore, other sores appear by auto-inoculation; it begins as a pustule, which bursts and exposes an ulcer; this ulcer is circular, has thin, sharp-cut or undermined edges, a sloughy, non-granulating base, and a thin, purulent, offensive discharge which is both auto- and hetero-inoculable. These soft sores have no true sclerotic area, do not bleed, produce no constitutional symptoms, and are apt to be followed by an acute inflammatory bubo which tends to suppurate. A chancroid causes pain. A chancre appears in about three weeks after inoculation (never before ten days); it is generally single, but if multiple sores exist, they all appear

together, for their discharge is not auto-inoculable; it begins as an excoriation or as a nodule; if an ulcer forms, its base is covered with granulations and it is red and smooth; its discharge is thin and scanty and not offensive; its edges are thick and sloping; it is surrounded by an area of induration, and bleeds when touched; it is followed by secondary symptoms, and there appear about the same time with it indolent multiple enlargements of the adjacent glands, which rarely suppurate. A chancre causes little pain.

Herpetic ulceration has no period of incubation; it may follow fever, but usually arises from friction or the irritation of dirt or acrid discharges. It appears as a group of vesicles, all of which may dry up, or some may dry up and others ulcerate, or they may run together and ulcerate. The edges of a herpetic ulcer are in "segments of small circles" (White); the ulcer is superficial, has but little discharge, and does not have much tendency to spread; it has no induration; it is painful; it has no bubo unless suppuration is extensive, and there is no constitutional involvement. A urethral chancre appears after the usual period of incubation; it is situated near the meatus, one lip of which is usually indurated; the discharge is slight, often bloody, and never purulent; indurated multiple buboes arise; the sore can be seen, and constitutional symptoms follow (White). "A chancre may be mistaken for cancer of the tongue. A chancre of this region is brownish-red, a cancer being bright red. A chancre is soft in the centre; a cancer presents uniformity of induration. A chancre has a thin, purulent discharge, free from blood; a cancer has a non-purulent, bloody discharge. A chancre is followed by indolent lymphatic enlargements under the jaw; a cancer is followed by painful enlargements." A cancer is slower in evolution, is not followed by constitutional symptoms, and the lymphatic enlargements are much later in appearing than in chancre.

Syphilitic Bubo.—In syphilitic bubo anatomically-related lymphatic glands enlarge about the same time as induration of the initial lesion begins. In the very beginning these glands may be a little painful, but they soon cease to be so. These enlargements are called "indolent buboes;" they may be as small as peas or as large as walnuts, are freely movable, and very rarely suppurate. The lesion of these glands is hyperplasia of all the gland-elements and of their capsules, due to absorption of the virus. If a man is strumous, the bubo is apt to become enormous, lobulated, and persistent. If the chancre appears on the penis, the superficial inguinal and femoral glands enlarge, usually on the same side of the body as the sore; if the sore is on the frænum, both groins are involved. These buboes may remain for many months; they do not suppurate unless the sore suppurates or there is some condition such as scrofula; and they finally disappear by absorption or fatty degeneration. About six weeks after buboes have formed in the glands related to the lesion, all the lymphatics of the body enlarge. General lymphatic involvement arises about the same time as the secondary eruption. The enlargement of the post-cervical and epitrochlear glands is diagnostically important. These glandular enlargements persist until after the eruptions have disappeared.

The bubo of syphilis is always present, while the bubo exists in only one-third of the chancroid cases. The bubo of syphilis is multiple, consisting of a chain of movable glands (the glandulæ Pleiades of Ricord); the bubo of chancroid is one inflamed and immovable mass. The bubo of syphilis is indurated, painless, small, and slow in growth; the bubo of chancroid shows inflammatory hardness, is painful, large, and rapid in growth; the first rarely suppurates, the second often does. The skin over a syphilitic bubo is normal; that over a chancroidal bubo is red and adherent. A syphilitic bubo is not cured by local treatment, but is

cured by the internal use of mercury and is followed by secondary symptoms. A chancroidal bubo requires local treatment, is not cured by mercury, and is not followed by secondaries. Herpes, balanitis, and gonorrhœa rarely cause bubo, but when they do the bubo in each case is similar to that caused by chancroid. A positive diagnosis of syphilis can be made when an indurated sore is followed by multiple indolent buboes in the groin and by enlargement of distant glands.

General Syphilis.—As the general lymphatic enlargement becomes manifest there is apt to appear a group of symptoms known as "syphilitic fever." The patient usually thinks he has a bad cold and is feverish and restless; he complains of sleeplessness and anorexia; his face is pale; he has intermitting rheumatoid pains in the joints and muscles, especially of the shoulders, arms, chest, and back, which pains change their location constantly and prevent sleep; night-sweats occur, and the pulse is quite frequent. This fever usually reaches its height in forty-eight hours, and falls as the eruption develops. Syphilitic fever does not always arise; it may appear during the progress of the disease.

Secondary Syphilis.—The phenomena of secondary syphilis arise from poisoned blood. They are characterized by plastic inflammation, by the formation of fibrous tissue, and by thickening of tissue. Ulcerations may occur. Structural overgrowths appear (warts).

Syphilitic Skin Diseases.—*Syphilodermata* (syphilides), due to circumscribed inflammation, may be dry or purulent. There is no one eruption characteristic of syphilis. This disease may counterfeit any skin disease, but it is an imitation which is not perfect and is never a counterpart. Syphilitic eruptions are often circumscribed; they terminate suddenly at their edges, and do not gradually shade into the sound skin. In color they are apt to be brownish-red, like tarnished cop-

per; especially is this the case in late syphilides. Hutchinson cautions us to remember that an ordinary non-specific eruption may be copper-colored, especially in people with dark complexion and when it occurs on the legs. Eruptions are apt to leave a brownish stain. Early syphilitic eruptions are symmetrical. Syphilitic eruptions have an affection for particular regions, such as the forehead, the abdomen and chest, the neck and scalp, about the lips and the alæ of the nose, the navel, anus, groins, between the toes, and upon the palms and soles. Early secondary eruptions rarely appear on the face or hands. Specific eruptions are polymorphous, various forms of eruption being often present at the same time, so that roseola is seen here, papules there, etc. These syphilides do not cause as much itching as do non-specific eruptions, except when about the anus or between the toes.

Forms of Eruption.—The chief forms of eruption are (1) erythema, (2) papular syphilides, (3) pustular syphilides, and (4) tubercular syphilides.

1. *Erythema* (*macula*, *roseola*, or *spots*) presents round, circumscribed, red, inflamed spots whose color does not entirely disappear on pressure. In the papular form of erythema the spots are a little elevated. It attacks especially the chest and belly, but appears often on the forehead, the bend of the elbow, and the inner portion of the thigh. Usually erythema follows syphilitic fever, about six weeks after the chancre appears, and the number and distinctness of these spots are in proportion to the violence of the fever. Absent or slight fever means few and transient spots. In rare cases the disease is very transitory, lasting but a few hours, but it usually lasts for a long period if untreated. Mercury will cause it to disappear in a couple of weeks. In examining for this form of eruption in a doubtful case, let cold air blow upon the chest and belly (Hearn); this blanches the sound skin and

makes clear any discoloration. Erythema means, as a rule, a mild and curable attack.

2. *Papular syphilides*, which are papules or elevations covered with dry skin, may or may not have a crust. They are at first red, but become brownish. Papules upon the palms and soles constitute the so-called "palmar and plantar psoriasis," which appears about eight or nine weeks after the appearance of the chancre in an untreated case. These papules just below the line of the hair on the forehead constitute the *corona venerea*. This eruption affects especially the forehead, the neck, the abdomen, and the extremities. The papular or squamous syphilide of the palms and soles begins as a red spot which becomes elevated and brownish; the epidermis thickens and is cast off, and there then remains a central red spot surrounded by undermined skin. If papules are in regions where they are kept moist (as about the anus), they become covered with a sodden gray film which comes off and leaves the papule without epidermis. These sodden papules are called "flat condylomata," moist or humid papules or plates. The papular syphilide gives a worse prognosis than roseola.

3. *Pustular syphilides* arise from papules. We have *acne* when the apex of a papule softens, *impetigo* when the whole papule suppurates, and *ecthyma* or *rupia* when the corium is also deeply involved. Vesicles often precede pustules, the pustular eruption coming out some months after infection (later than the papular). The pustular eruption gives a very bad prognosis. Rupia is formed by a pustule rupturing or a papule ulcerating, the secretion drying and forming a conical crust which continually increases in height and diameter, while the ulceration extends at the edges. When the crust is pulled off there is seen a foul ulcer with congested, jagged, and undermined edges. Rupia may be secondary or tertiary, and it invariably leaves scars. It appears only after at least

six months have passed since the chancre began. Secondary rupia is symmetrical.

4. *Tubercular syphilides* are greatly enlarged papules intermediate between ordinary papules and gummata.

Diagnosis between Secondary and Tertiary Syphilides.—A secondary eruption is distinguished from a tertiary eruption by the following: the first tends to disappear, the second tends to persist and to spread; the first is symmetrical, the second is asymmetrical; the first does not spread at its edge, the second tends to spread at its edge, and this tendency, which is designated "serpiginous," produces an ulcer shaped like a horse-shoe (Jonathan Hutchinson).

Affections of the Mucous Membranes.—The chief lesions in syphilitic affections of the mucous membranes are mucous patches, warts, and condylomata. The first phenomena of secondary syphilis are, as a rule, symmetrical ulcers of the tonsils, painless and superficial (Hutchinson). The borders of the ulcers are gray, and the areas are reniform in shape. They rarely last long. Catarrhal inflammations often occur. Eruptions appear on the mucous membranes or upon the skin. Mucous patches are papules deprived of epithelium; they are gray in color, are moist, and give off an offensive and virulent discharge. They usually appear as areas of congestion, swelling, and abrasion of the epidermis upon the lips, palate, gums, tongue, cheeks, vagina, labiæ, vulva, scrotum, anus, and under the prepuce. A moist papule of the skin is really a mucous patch. These patches, which are always circular or oval, are among the most constant lesions of the secondary stage, appearing from time to time during many months. If a patch has the papillæ destroyed, it is called a "bald patch." If the papules present hypertrophied papillæ fused together, there appear enlargements with flat tops termed "condylomata;" if the papillæ of the papule hypertrophy and do not fuse, the growths are called "warts."

Mucous lesions of the mouth are commonest in smokers and in those with bad or neglected teeth. Hutchinson says that persistence in smoking during syphilis may cause leucomata, or persistent white patches. The larynx may suffer from inflammation, eruptions, and ulceration (hence the hoarse voice which is so usual). The nasal mucous membrane may also suffer.

Affections of the Hair.—In syphilitic affections the hair is shed to a great extent. This loss may be widespread (beard, mustache, head, eyebrows, pubic hair, etc.) or it may be limited. Complete baldness sometimes ensues, but this is rarely permanent. The hairs are first noticed to come out on the comb; on pulling them they are found loose in their sheaths—so loose that Ricord has said "a man would drown if a rescuer could pull only upon the hair of the head." This falling out of the hair, which is known as "alopecia," begins soon after the fever or about the time of the eruption, but it may be postponed. The skin of a syphilitic bald spot is never smooth, but is scaly. The hair may thin generally, baldness may appear in twisting lines, or it may be complete only in limited areas. Alopecia results from shrinking of the hair-pulp, death of the hair, and casting off of the sheath.

Affections of the Nails.—Paronychia is inflammation and ulceration of the skin in contact with a nail and extending to the matrix. The nail is cast off partially or entirely. Onychia is manifested by white spots, brittleness or extended opacity, twisting, and breaking off of the nail. The parts around are not affected. The damaged nail drops off and another diseased nail appears.

Affections of the Ear.—Temporary impairment of hearing in one or both ears is not uncommon in syphilitic affections of the ear. Rarely, permanent symmetrical deafness is produced. Ménière's disease is sometimes caused by syphilis.

Affections of the Bones and Joints.—In syphilis there

may be slight and temporary periostitis. Pain and tenderness arise in various bones, the pain being worse at night (osteoscopic pains). The bones usually involved are the tibiæ, clavicles, and skull. Pain like that of rheumatism affects the joints. Local periostitis may form a soft node which by ossification becomes a hard node.

Affections of the Eye.—Iritis is the commonest trouble of the eyes. It appears from three to six months after the chancre, and begins in one eye, the other eye soon becoming affected. The symptoms are a pink zone in the sclerotic, ciliary congestion, muddy iris, irregular pupil accentuated by atropine, pain and photophobia, and sometimes hazy or even blocked pupil. Rheumatic iritis causes much pain and photophobia, syphilitic iritis comparatively little; there is less swelling in the first than in the second; the former tends to recur, the latter does not. Iritis is usually recovered from, good vision being retained. Diffuse retinitis and disseminated choroiditis never occur until a number of months have passed since the infection. The symptoms are failure of sight, muscæ volitantes, and very little photophobia. Diagnosis of retinitis and choroiditis is by the ophthalmoscope.

Affections of the Testes.—*Syphilitic Sarcocele.*—The testes enlarge from plastic inflammation. Both glands usually suffer, but not always. Fluid distends the tunica vaginalis. The epididymis escapes. The testicle is not the seat of pain, is troublesome because of its weight, and has very little of the proper sensation on squeezing. The plastic exudate is generally largely absorbed, but it may organize into fibrous tissue, the organ passing into atrophic cirrhosis.

Intermediate Period.—In this period no symptoms may appear, but the disease is still for some time latent and is not cured. Symptoms may appear from time to time. These symptoms, which are called "reminders," are not so severe as tertiary symptoms; reminders are apt to be symmetrical, and

they do not closely resemble secondary lesions. Among the reminders we may name palmar psoriasis, sarcocele, sores on the tongue, a papular skin-eruption, and choroiditis. Gummata occur in this stage, but they are apt to be symmetrical and non-persistent. Arteritis occurs, beginning in the intima or adventitia, and causing, it may be, aneurysm, embolism, or thrombosis. Obliterative endarteritis may cause gangrene. This vascular condition is frequent in the brain; thrombosis may occur, in which case a paralysis comes on gradually, preceded by numbness, although sudden paralysis may occur. These paralyses may be limited, extensive, transitory, or permanent. The nervous system often suffers in this stage (anæsthetic areas and retinitis). The viscera are often congested and infiltrated (tonsils, liver, spleen, kidneys, and lungs).

Tertiary Syphilis.—This stage is not often reached, the disease being cured before it has been attained. It is regarded by many as not so much a stage of syphilis as a condition of impaired nutrition which results from the disease. This view finds confirmation in the fact that tertiary lesions do not furnish the contagion. The primary stage disappears without treatment, the secondary stage tends ultimately to spontaneous disappearance, but tertiary lesions tend to persist and to recur. Tertiary lesions may be single or may be widely scattered; when multiple they are not symmetrical except by accident. These lesions may attack any tissue, even after many years of apparent cure; they all tend to spread locally, they all leave permanent atrophy or thickening, they all tend to relapse, and a local influence is often an exciting cause.

Tertiary skin-eruptions are liable to ulcerate. The characteristic syphilide is *rupia*, which is formed by a pustule rupturing or a papule ulcerating. A scab forms because of the drying of the discharge, ulceration continues under the scab,

new scabs form, and, as the ulcer is constantly increasing peripherally, the new scabs are larger in diameter than the old ones, and the crust assumes the form of a cone. An ulcer is exposed by tearing off the scab, which ulcer has destroyed the deeper layers of the skin, and on healing always leaves a permanent scar.

Ulcers are common in tertiary syphilis. They are frequent on the legs, especially about the knees. A syphilitic ulcer is usually crescentic, its edges are thin and sharp, its base is foul and sloughy, and its discharge is scanty and tenacious.

Gumma.—The gumma is the typical tertiary lesion. A gumma arises from an inflammation the products of which cannot organize for want of sufficient blood-supply, and consequently they undergo fatty degeneration. A gumma presents a centre of gummy degeneration, a surrounding area of immature fibrous tissue, and an outer zone of embryonic tissue and leucocytes. A gumma, when it is spontaneously evacuated, exhibits a small opening with very thin undermined edges; the ulcer is slow to heal, and forms a depressed scar. A gumma in the internal organs may become a fibrous mass. These gummata form in the skin, subcutaneous tissues, muscles, tongue, joints, bursæ, testes, spinal cord, brain, and internal organs. In tertiary syphilis an inflammation may not form a circumscribed gumma, but, instead, may produce a diffuse degenerating mass. This type of inflammation, which is seen in bones, is called "gummatous." A healing gumma in a mucous canal such as the rectum or larynx causes thickening and stricture. Tertiary syphilis is a most common cause of amyloid degenerations and arterial and nervous sclerosis.

Various Lesions.—Hutchinson enumerates the lesions of tertiary syphilis as follows: *Periostitis*, forming nodes or causing sclerotic hypertrophy or suppuration or necrosis; gummata in various parts; disease of the skin of the type

of rupia or lupus; gumma or inflammation of tongue, causing sclerosis; structural changes in the nervous system, causing ataxia, ophthalmoplegia externa and interna, general paresis, optic atrophy, and paralyses of cerebral nerves; amyloid degenerations; and chronic inflammation of certain mucous membranes (of the mouth, pharynx, vagina, rectum, etc.), with thickening and ulceration.

Visceral Syphilis.—In visceral syphilis the lungs may undergo fibroid induration (syphilitic phthisis). Syphilitic phthisis is a non-febrile malady. Gummata may form in the heart, liver, spleen, or kidneys; the capsule and fibrous septa of the liver may thicken, the organ being puckered from contraction. Amyloid changes may appear in any of the viscera.

Nervous syphilis may be manifest in disorders of the brain, cord, or nerves. Much of our knowledge of these conditions is due to Wood. He says brain syphilis is usually a late phenomena (from one to thirty years), and is more apt to appear after light secondaries. The lesion may be gumma of the membranes (tumor), gummatous meningitis, arterial atheroma, or obliterative endarteritis. A gumma may eventuate in a scar, a cyst, or a calcareous mass. The symptoms of brain syphilis depend on the nature, seat, and rate of development of the lesions. It is to be noted that syphilitic palsy is apt to be limited, progressive, and incomplete. Epilepsy appearing after the thirtieth year is very probably specific if alcohol can be ruled out. Persistent headache, insomnia or somnolence, transitory limited palsies, unnatural slowness of utterance, amnesia, vertigo, and epilepsy are very suggestive. The more usual type of insanity is a likeness or counterpart of general paralysis. Spinal syphilis may cause sclerosis, a condition like Landry's paralysis, softening, and tumor. Neuritis is not uncommon in syphilis.

Treatment of Primary Stage.—A chancre should not be

excised. The disease is constitutional when the chancre appears, and excision and cauterization inflict needless pain and do no good. The initial lesion should never be burned unless it is phagedænic or becoming so. Order the patient to soak the penis for five minutes twice daily in warm salt water (a teaspoonful of salt to a cupful of water), and then to spray the sore by an atomizer with peroxide of hydrogen (14-volume solution of peroxide diluted with an equal bulk of water). The ulcer is then dried with absorbent cotton and on it is dusted a powder of equal parts of bismuth and calomel. The buboes in the groin require no local treatment unless they tend to suppurate. If they persist or become large, paint them with iodine, smear blue ointment over them, and apply a spica bandage of the groin. Ichthyol and lanolin make an excellent application for the enlarged glands, and so does mercurial ointment. Some authorities give mercury in this stage, claiming that it prevents secondaries. The late S. W. Gross opposed this strongly, and affirmed a wish to see the secondary eruption—first, because it proves the diagnosis; and second, because it affords valuable prognostic indications (an erythematous eruption means a light case; an early pustular eruption means a grave case with serious complications). Dr. White will not order mercury until constitutional symptoms develop.

Treatment of Secondary Stage.—In the secondary stage the aim is to cure the disease. That it can be cured is known from the fact that reinfection occurs in some persons. The old axiom, "Syphilis once, syphilis ever," is not true. Mercury must be used, the form being a matter of choice. Fournier first advocated intermittent treatment. In this plan give gr. $\frac{1}{3}$ of protiodide of mercury daily for six months, then stop a month; then give mercury for three months, then stop two months. During the first year the patient is

under treatment nine months, and during the second year eight months. Some prefer the intermittent and others the continuous plan of treatment. Dr. White greatly prefers the continuous plan. The rule in most cases is to give mercury for two years. Find the patient's dose of tolerance, and keep him on this amount. Gross's rule for continuous treatment was to order pills of the green iodide of mercury, each pill containing gr. $\frac{1}{6}$. The patient was ordered one pill after each meal to begin with; the next day he took two pills after breakfast; the following day, two after dinner, and so on, adding one pill every day. This advance was continued until there was slight diarrhœa, griping, a metallic taste, or tenderness on snapping the teeth together, whereupon one pill was taken off each day until all unfavorable symptoms disappeared. This experimentation gives a dose on which the patient can be kept with entire safety for a long time, but if it is found that colic or diarrhœa is apt to recur, there must be added to each pill gr. $\frac{1}{12}$ of opium. The patient is given mercury in this way for two years. Every time new symptoms appear the dose is raised, and as soon as they disappear it is lowered to the standard. If the protiodide is not tolerated, give the bichloride:

℞. Hydrarg. chlor. corros.,	gr. iss;
Syr. sarsaparillæ comp.,	f℥iv.—M.
Sig. fʒj in water after meals.	

Mercury with chalk in 1-grain doses four times a day, with or without Dover's powder in ½-grain doses, can be used. Mercurial inunctions produce a rapid effect, but irritate the skin. There can be used once a day ½ drachm of oleate of mercury (10 per cent.) or 1 drachm of mercurial ointment, rubbed in one day on the inside of one thigh and the next day on the inside of the other thigh; next, the inside of one arm and then the other arm; next, one groin and then the

other groin, and so on. After the rubbing the patient puts on underclothes and goes to bed, and in the morning takes a bath. The ointment may be smeared on a rag, which is then worn between the stocking and sole of the foot during the day.

Fumigation is performed by volatilizing each night ʒj of calomel. The patient sits naked on a cane-seat chair, the calomel is heated by an alcohol lamp beneath the chair, and wrapped around the patient is a blanket which drops tent-like to the floor. The skin becomes coated with calomel, and the subject, after putting on woollen drawers and an undershirt, gets into bed. Hypodermatic injections of mercury are used by some physicians. They cause an eruption to disappear rapidly, but may produce abscesses, and relapses are prone to occur. The usual plan is to give daily a hypodermatic injection of corrosive sublimate deep into the back or buttocks, the dose being gr. $\frac{1}{4}$ of the drug. Thirty such injections are used unless some indication points to their discontinuance sooner. The treatment is then stopped. If the symptoms recur, however, the patient is given another course, the daily dosage being gr. $\frac{1}{6}$, the treatment being again stopped after thirty injections, but continued anew in $\frac{1}{8}$-grain doses if the symptoms recur. Dr. Orville Horwitz has recently made thorough trial of this method, and arrives at the following conclusions: It will not abort the disease; it should never be a routine treatment; in suitable cases it is very valuable for symptomatic use, as when lesions on the face or in important structures make a rapid impression desirable or necessary; in cases which obstinately relapse under other treatment, and in syphilis of the nervous system.

Dr. J. William White, who has the right to speak authoritatively, says that hypodermatic injections of corrosive sublimate are painful and are strongly objected to by many patients; that this method of treatment is occasionally danger-

ous and even fatal; that it is liable to be followed by local complications (erythema, nodosities, cellulitis, abscess, sloughing); that it cannot be carried out by the patient, but requires the surgeon's constant intervention. This distinguished syphilographer concludes that hypodermatic medication does not offer advantages justifying its use as a systematic method of treatment, and that it encourages insufficient treatment—those "short heroic courses" which Hutchinson shows are followed by the gravest tertiary lesions. "The claim that by a few injections the time of treatment can be measured by months or even by weeks, instead of by years, would seem, as Mauriac has said, to involve the idea that mercury given hypodermatically acquires some new and powerful curative property which, given in other ways, it does not possess."[1] In whatever way mercury is given, do not let it salivate (hydrargyrism).

Acute Ptyalism, or Salivation.—In acute ptyalism the saliva becomes thick and excessive in amount; the gums become tender (found first by snapping the teeth), spongy, and tend to bleed; a metallic taste is complained of; the breath becomes fetid; all the oral structures swell; the teeth loosen; the saliva is enormously increased; and there are purging, colic, and exhaustion. A chronic hydrargyrism may be shown by gastro-intestinal disorder, emaciation, mental depression, weakness, albuminuria, and tremor. To avoid salivation cautiously advance the dose and instruct the patient as to the first signs. He should use a soft tooth-brush and an astringent mouth-wash (gr. xlviij of boracic acid to ℥iv each of listerine and water). When ptyalism begins, stop the drug. Employ the above mouth-wash or one composed of a saturated solution of chlorate of potassium. Order gr. $\frac{1}{120}$ of atropine twice a day, and in bad

[1] Prof. J. William White, in Morrow's *System of Genito-urinary Diseases, Syphilis, and Dermatology*.

cases spray the mouth with peroxide of hydrogen and use silver nitrate locally (gr. xx to ℥j). A weekly Turkish bath is of great use. In chronic hydrargyrism stop the drug, use tonics, stimulants, open-air exercise, Turkish baths, and good food. The chloride of gold and sodium forms a good substitute drug.

Treatment of Complications in Secondary Stage.—The complications of the secondary stage usually require local applications in addition to general remedies. Mucous patches in the mouth should be touched with bluestone every day, an astringent mouth-wash being employed several times daily. If the patches ulcerate, they should be touched twice a day with lunar caustic; if these areas proliferate, they should be excised and burned. Vegetations or growing papules on the skin must, if calomel powder fails to remove them, be cut away with scissors and be cauterized with chromic acid or with the Pacquelin cautery. Condylomata demand washing with ethereal soap several times daily, thorough drying, dusting with equal parts of calomel and subnitrate of bismuth or with borated talcum, and covering with dry bichloride gauze. If these simple procedures fail, then excise and cauterize.

For psoriasis of the palms and soles diachylon ointment, mercurial plaster, or painting with tincture of iodine should be employed. Ulcers of paronychia are dressed with iodoform and corrosive-sublimate gauze. Deep cutaneous ulcers are cleaned once a day with Johnson's ethereal soap, then sprayed with peroxide of hydrogen, dressed with iodoform and corrosive-sublimate gauze, and bandaged. When granulation is well established dress with 1 part of unguent. hydrarg. nitratis to 7 parts of cosmoline. In sarcocele mercurial ointment should be used or the testicle be strapped. Alopecia requires that the hair be kept short and every night the scalp be cleaned with equal parts of

green soap and alcohol rubbed into a lather with water. After the soap is washed out some hair tonic should be rubbed into the scalp with a sponge.

In treating persistent skin-lesions, inunctions, injections, or fumigations may be used; some prefer mercurial baths. Baths are suited to patients with delicate skins, to those whose digestion fails from mercury by the stomach, and to those whose lungs will not tolerate fumigations. Half an ounce of corrosive sublimate with 4 scruples of sal ammoniac are mixed in about 4 ounces of water; this is added to a bath at a temperature of 95°. The patient gets into this bath, covers the tub with a blanket, leaving only his head exposed, and remains in the bath an hour or so. These baths may easily cause salivation.

In every case of syphilis, no matter what constitutional or local treatment is used, the general health of the patient must be watched and the use of tobacco be stopped, as the latter renders certain the arrival of mucous patches and causes them to persist. Alcohol as a beverage must be cut off: its use must only be as a medicine for debility and weakness of assimilation. An open-air life to a great degree must be insisted upon, and care be observed as to protection from damp and cold. Order flannels in winter. Have the patient sponge the chest and shoulders every morning with cold or with tepid water and then with alcohol, drying himself with a rough towel, and take a hot bath twice a week or a Turkish bath once a week. He should wash the anus and nates after every stool, and ought to dust the axillæ, scrotum, perineum, and internatal region once a day with borated talc. The teeth are to be looked to and put in perfect order, a soft brush being used twice a day and an astringent mouth-wash being frequently employed. Meat and milk are largely to be used. The patient should be weighed weekly: any falling off in weight is an indication for tonics, concentrated

food, and cod-liver oil. If a patient's health continues to fail on mercury, the drug should be stopped for some time and the patient be treated with iron, chloride of gold and sodium, baths, fresh air, cod-liver oil, and nourishing foods. Reminders require mixed treatment.

Tertiary Stage.—If at any time during the case there appear tertiary symptoms, the patient should be put on mixed treatment. In any case, after two years of mercury add iodide of potassium to the treatment. Dr. White's rule is to use this mixed treatment for at least six months (if any symptoms appear), the six-months course dating from their disappearance. This emphasizes the fact that the iodides alone will not cure tertiary syphilis. In obstinate tertiaries or in nervous syphilis the iodides should be run up to an enormous amount (from 30 to 250 grains per day). An easy way to give iodide is to order a saturated solution each drop of which equals one grain of the drug. Each dose of the iodide is given one hour after meals and in at least half a glass of water. If the iodide disagrees, it may be given in water containing one drachm of aromatic spirits of ammonia or in milk. The iodide of sodium may be tolerated better than the potassium salt, or the iodides of sodium, potassium, and ammonium may be combined. In giving the iodides begin with a small dose. During a course of the iodide always give tonics and insist on plenty of fresh air. Arsenic tends to prevent skin-eruptions. The iodides when they disagree produce iodism—a condition which is first made manifest by running of the nose and the eyes. In some subjects there is an outbreak of acne, vesicular eruptions or even bullæ, or hemorrhages. Iodism calls for a reduction in dosage, and, if severe or persistent, for the abandonment of the drug. After the patient has been for six months under mixed treatment without a symptom, stop all treatment and await developments. If during one year no symptoms recur,

the patient is probably cured; if symptoms do recur, there must be six months more of treatment and another year of watching.

Hereditary Syphilis.—*Transmitted congenital syphilis* is a hereditary syphilis manifest at birth. Acquired syphilis (except in the case of a woman who obtains the disease from a fœtus) always presents the chancre as an initial lesion; hereditary syphilis never does. Hereditary syphilis may present itself at birth, and usually shows itself within, at most, the first six months of extra-uterine life. In rare cases (tardy hereditary syphilis) the disease does not become manifest until puberty.

Rules of Inheritance.—According to Von Zeissl,[1] the rules of inheritance are as follows:

1. If one parent is syphilitic at the time of procreation, the child may be syphilitic.

2. Syphilitic parents may bring forth healthy children.

3. If a mother, healthy at procreation, bears a child syphilitic from the father, the mother must have latent pox or must be immune, having become infected through the placental circulation. She often shows no symptoms, having received the poison gradually in the blood, and having thus received, it may be said, preventive inoculations. Certain it is that mothers are almost never infected by suckling their own syphilitic children (Colles's law).

4. If both parents were healthy at the time of procreation, and the mother afterward contracts syphilis, the child may become syphilitic, and the earlier in the pregnancy the mother is diseased, the more certain is the child to be tainted. This is known as "infection in utero."

5. The more recent the parental syphilis, the more certain is infection of the offspring. The children are often stillborn.

[1] *Pathology and Treatment of Syphilis.*

6. When the disease is latent in the parents it is apt to be tardy in the children.

7. The longer the time which has passed since the disappearance of parental symptoms, the more improbable is infection of the children.

8. In most instances parental syphilis grows weaker, and after the parents beget some tainted children they bring forth healthy ones.

Many women who labor under hereditary syphilis are sterile. Many syphilitic women abort, usually before the eighth month. The fœtus very often dies at an early period of gestation. This may be due to a gummatous placenta or to a degeneration of placental follicles.

Evidences of Hereditary Syphilis (manifest at, or oftener soon after, birth).—Hutchinson says that at birth the skin is almost invariably clear. In a few weeks "snuffles" begin, which are soon followed by a skin-eruption, by body-wasting, and by a chain of secondary symptoms (iritis, mucous patches, pains, condylomata, etc.). The child looks like a withered-up old man. Eruptions are met with on the palms and soles. Intertrigo is usual. Cracks occur at the angles of the mouth, and leave permanent radiating scars. The abdomen is tumid, and there is apt to be exhausting diarrhœa. Atrophic lesions may appear in the bones. In the skull the bone may be softened by removal of its salts or be thinned by the pressure of the brain. In the long bones the epiphyseal ends suffer, the attachment of epiphysis to shaft is weak, and separation is easily induced. Suppuration of the epiphysis is common. Osteophytic lesions of the skull are shown by symmetrical spots of thickening upon the parietal and frontal bones (natiform skulls). In the long bones osteophytes are frequently formed. A child with precocious hereditary syphilis is apt to die, but if it lives from six months to one year the symptoms for a time disappear and for years the disease may be

latent. When the disease begins again the symptoms are various, namely: noises in the ears, often followed by deafness; interstitial keratitis; dactylitis (specific inflammation of all the structures of a finger); synovitis in any joint; ossifying nodes; developmental osseous defects; suppurative periostitis; ulcerations; death of bone; falling in of nose; nervous maladies; occasionally sarcocele, etc.

Diagnosis.—In the diagnosis of hereditary syphilis the condition of the teeth is of much importance: the temporary teeth decay soon, but present no characteristic defect. If the upper permanent central incisors are examined, other teeth may show defects, but in these alone are defects almost sure to appear. In hereditary syphilis they present an appearance of marked deviation from health, and are called "Hutchinson teeth" (Pl. 1, Fig. 4). If they are dwarfed, too short and too narrow, and if they display a single central cleft in their free edge, then the diagnosis of syphilis is almost certain. If the cleft is present and the dwarfing absent, or if the peculiar form of dwarfing be present without any conspicuous cleft, the diagnosis may still be made with much confidence. In early infancy the diagnosis is made by the snuffles, broad nose, skin-eruptions, wasted look, sores at the mouth-angles, tenderness over bones, condylomata, and history of the parents. The diagnosis at a later period is made by the existence of symmetrical interstitial keratitis, deafness which comes on without pain or running from the ear, ossifying nodes, white radiating scars about the mouth-angles, sunken nose, natiform skull, deformity of long bones, suppuration of epiphyses, and Hutchinson teeth. It must be remembered that a child apparently born healthy and presenting no secondary symptoms may show bone disease, keratitis, or syphilitic deafness at puberty.

Treatment.—In infants inunctions are to be used until the symptoms disappear, but mercury must not be forced or

continued too long after the symptoms are gone. There must be rubbed into the sole of each foot or the palm of each hand 5 grains of mercurial ointment every morning and night. Brodie advised spreading the ointment (in the strength of ʒj to the ounce) upon flannel and fastening it around the child's belly. If the skin is so tender that mercury must be given by the mouth, White and Hearn advise that gr. $\frac{1}{12}$ to gr. $\frac{1}{2}$ of mercury with chalk with 1 grain of sugar be taken three times a day after nursing. If tertiary symptoms appear, or in any case when the secondaries disappear, give gr. ss to gr. j or more of iodide of potassium several times a day in syrup. White advocates the continuance of the mixed treatment intermittently until puberty. Local lesions require local treatment as in the adult. A syphilitic child must be nursed by its mother, as it will poison a healthy nurse. If the mother cannot nurse the child, it must be brought up on the bottle. For the cachexia use cod-liver oil, iodide of iron, arsenic, and the phosphates.

XVI. TUMORS OR MORBID GROWTHS.

Division.—Morbid growths are divided into (1) neoplasms and (2) cysts.

Neoplasms.—A neoplasm is a pathological new growth which tends to persist independently of the structures in which it lies, and which performs no physiological function. A hypertrophy is differentiated from a tumor by the facts that it is a result of increased physiological demands or of local nutritive changes and that it tends to subside after the withdrawal of the exciting stimulus. Further, a hypertrophy does not destroy the natural contour of a part, while a tumor does. Inflammation has marked symptoms: its swelling does not tend to persist, it terminates in resolution, organization, or suppuration, and the microscope differentiates it from tumor. Inflammation, too, has an assignable exciting

cause. A new growth means a mass of new tissue; hence it is improper to designate as tumors those swellings due to extravasation of blood (as in hæmatocele) or of urine (from ruptured urethra), to displacement of parts (as in hernia, floating kidney, or dislocation of the liver), or to fluid distention of a natural cavity (as in hydrocele or bursitis).

Classes of Tumors.—There are two classes of tumors: the first class includes those derived from or composed of ordinary connective tissue or of higher structures. These all originate from cells which are developed from the mesoblast. There are two groups of connective-tissue tumors: (*a*) the typical benign or innocent, which find their type in the healthy adult human body; and (*b*) the atypical or malignant, which find no counterpart in the healthy adult human body, but rather in the immature connective tissues of the embryo.

The second class of tumors includes those which are derived from or composed of epithelium: (*a*) the typical, composed of adult epithelium; and (*b*) the atypical, composed of embryonic epithelium.

Müller's Law.—Müller's law is that the constituent elements of neoplasms always have their types, counterparts, or close imitations in the tissues of a normal organism, either embryonic or mature.

Virchow's Law.—Virchow's law is that the cells of a tumor spring from pre-existing cells (hence there is no special tumor-cell or cancer-cell).

The term "heterologous" is no longer used to signify that the cellular elements of a tumor have no counterpart in the healthy organism, but is employed to signify that a tumor deviates from the type of the structure from which it takes its origin (as a chondroma arising from the parotid gland). Tumors when once formed almost invariably increase and persist, though occasionally warts, exostoses, and fatty

tumors do disappear. Tumors may ulcerate, inflame, slough, be infiltrated with blood, or undergo mucoid, calcareous, or fatty degeneration.

Causes.—The causes of tumors are not positively recognized, those alleged being but theories varying in probability and ingenuity.

The inclusion theory of Cohnheim supposes that more embryonic cells exist than are needful to construct the fœtal tissues, that masses of them remain in the tissues, and that these may be stimulated later into active growth. This embryonic hypothesis seems to receive a certain force from the facts that exostoses do sometimes develop from portions of unossified epiphyseal cartilage, and that tumors often arise in regions where there was a suppression of a fœtal part, closure of a cleft, or an involution of epithelium (epithelioma is usual at muco-cutaneous junctures). This theory, which does not explain the origin of most neoplasms, cannot successfully be maintained even as a common predisposing cause.

Hereditation is extremely doubtful. S. W. Gross found hereditary influence by no means always apparent in cancer of the breast. It is affirmed by some, denied by others, and doubted by a number. At most, hereditary influence can only predispose.

Injury and inflammation may undoubtedly prove exciting causes. A blow is not infrequently followed by sarcoma; the irritation of a hot pipe-stem may excite cancer of the lip; the scratching of a jagged tooth may cause cancer of the tongue; chimney-sweeps' cancer arises from the irritation of dirt in the scrotal creases; and warts often arise from constant contact with acrid materials.

Physiological activity favors the development of sarcoma, and *physiological decline* favors the development of cancer.

Parasitic Influence.—This theory does not maintain that the tumor is the parasite, but that it contains the parasite.

Some facts render a parasitic origin of malignant growths not improbable; as, for instance, the likeness of some tumors to infective granulomata, their occasional secondary development in distant parts of the body, the resemblance of the secondary to the primary growths, and the tenacity of their persistence. It is only just to state, however, that tumors do not seem to be hetero-inoculable. A parasitic origin of cancer is pointed to by its geographical distribution, the disease being very common in low and marshy districts (Havilland).

Actinomycosis, long thought to be a true tumor, is now known to arise from the ray-fungus. There can be no doubt that changes in the liver which practically constitute a new growth can arise from the growth of a cell called by Darier the "psorosperm." A disease due to psorosperms is called a "psorospermosis." It is affirmed by some that molluscum contagiosum, follicular keratosis, cancer, and Paget's disease are due to psorosperms. Some claim to find the parasite in all cases of cancer, while others can find it in only four or five per cent. of the cases.

Heneage Gibbes affirms[1] that dilatation of the bile-ducts of a rabbit's liver is caused by the chronic irritation arising from multiplication of the coccidium oviforme in them, and not in the columnar cells of the bile-ducts, as has been stated; and, further, that the large majority of glandular cancers show nothing that can be considered parasitic, the suspicious appearances noted in some few cases being due to endogenous cell-formation. This coccidium oviforme is a genus of the sporozoa, class protozoa, the lowest division of the animal kingdom. To this class belong the monera and infusoria.

Malignant and Innocent or Benign Tumors.—Malignant growths infiltrate the tissues as they grow; benign tumors only push the tissues away; hence malignant tumors are not thoroughly encapsuled, while innocent tumors are

[1] *The American Journal of Medical Sciences*, July, 1893.

encapsuled. Malignant tumors grow rapidly; innocent tumors grow slowly. Malignant tumors become adherent to the skin and cause ulceration; innocent tumors rarely adhere and rarely cause ulceration. Many malignant tumors give rise to secondary growths in adjacent lymphatic glands (cancer, except in the stomach, gullet, and upper jaw, always so tends); sarcoma does not cause them, unless it be melanotic or unless it arises from the testicle or tonsil. Innocent tumors never cause secondary lymphatic involvement, although the glands near the tumor may enlarge from accidental inflammatory complications. The malignant tumors, especially certain sarcomata and soft cancers, may be followed by secondary growths in distant parts and various structures (bones, viscera, brain, muscles, etc.); innocent tumors are not followed by these secondary reproductions, although multiple fatty tumors or multiple lymphomata may exist. Malignant tumors destroy the general health; innocent tumors do not. Malignant tumors tend to recur after removal; innocent tumors do not if operation was thorough.

Classification.—Tumors may be classified as follows:

I. Connective-tissue tumors.

1. Innocent tumors, or those composed of mature connective tissue:

Lipomata, or fatty tumors; *fibromata*, or fibrous tumors; *chondromata*, or cartilaginous tumors; *osteomata*, or bony tumors; *odontomata*, or tooth-tumors; *myxomata*, or mucous tumors; *myomata*, or muscle-tumors; *neuromata*, or tumors upon nerves; *angeiomata*, or tumors formed of blood-vessels; *lymphangeiomata*, or tumors formed of lymphatic vessels; and *lymphomata*, or tumors of lymphatic glands.

2. Malignant tumors, or those composed of embryonic connective-tissue:

Sarcomata.

II. Epithelial tumors.

1. Innocent tumors, or those composed of mature epithelial tissue:

   Adenomata, or tumors whose type is a secreting gland; and *papillomata*, or tumors whose type is found in the papillæ of skin and mucous membranes.

2. Malignant tumors, or those composed of embryonic epithelial tissue:

   Carcinomata, or cancers.

1. **Innocent Connective-tissue Tumors.**—The growths mimic or imitate some connective tissue or higher tissue of the mature and healthy organism.

Lipomata are tumors composed of fat contained in the cells of connective tissue, which cells are bound together by fibres. If the fibres are excessively abundant, the growth is spoken of as a "fibro-fatty tumor." A fatty tumor has a distinct capsule, tightly adherent to surrounding parts, but loosely attached to the tumor; hence enucleation is easy. Fibrous trabeculæ run from the capsule of a subcutaneous lipoma to the skin; hence movement of the integument over the tumor or of the tumor itself causes dimpling of the skin. Lipomata are most frequent in middle life, and their commonest situations are in the subcutaneous tissues of the back or of the dorsal surfaces of the limbs; they usually occur singly, but may be multiple and sometimes symmetrical. A lipoma is soft, doughy, mobile, lobulated, of uniform consistence, and may give on tapping a tremor or pseudo-fluctuation. The skin over a fatty tumor sometimes ulcerates from pressure; the tumor itself may inflame or partly calcify. When a lipoma has once inflamed, it becomes immovable. The commonest situation for lipomata is in the subcutaneous layer of fat. Subcutaneous lipoma of the palm of the hand or sole of the foot resembles a compound ganglion, and it is apt to be congenital. Lipomata of the head and face are

rare. In the subcutaneous tissues of the groins, neck, pubes, axillæ, or scrotum a mass of fat may form, unlimited by a capsule and known as a "diffuse lipoma." A nævo-lipoma is a nævus with much fibro-fatty tissue. Fatty tumors may arise in the subserous tissue, and when arising in either the femoral or inguinal canals or the linea alba they resemble omental herniæ and are spoken of as "fat-herniæ." In the retroperitoneal tissues enormous fibro-fatty tumors occasionally grow, and these neoplasms tend to become sarcomatous. Lipomata may arise from beneath synovial membranes and will project into the joints, being still covered by synovial membrane. Fatty tumors occasionally arise in submucous tissues, between or in muscles, from periosteum, and from the meninges of the spinal cord (Bland Sutton).

Treatment.—A single subcutaneous lipoma is to be removed. Open the capsule, tear out or dissect out the mass, and always drain for twenty-four hours, or butyric fermentation will be apt to occur. Multiple subcutaneous lipomata, if very numerous, should not be interfered with unless troublesome because of their size or situation, when they should be removed. Diffuse lipomata cannot be removed entirely, and operation is useless. Liquor potassæ has been recommended to limit growth; it is to be taken internally for a considerable time, but it seems to be useless. Subperitoneal lipomata are never diagnosticated until the belly has been opened or the growth has been removed.

Fibromata are tumors composed of wavy fibrous bundles. A fibroma has no distinct capsule, though surrounding tissues are so compressed as to simulate a capsule. Fibromata are most usual in young adults, but they may occur at any period of life, and are hard and movable. Pure fibromata, which are rare, are generally solitary, grow slowly, are of uniform consistence, and have not much circulation. Soft

fibromata grow more rapidly than do the hard, may become quite large, are apt to have distinct pedicles, and arise generally from the scrotum, labia, uterus, and on the inner surface of the arm or the thigh. Hard fibromata grow slowly; they may form upon nerves, they may arise in the mammary gland, and they may spring from various fibrous membranes, from the periosteum of the nasal bones (fibrous polypi), and from the gums (fibrous epulides). Fibromata may become cystic, calcareous, osseous, or sarcomatous.

A *painful subcutaneous tubercle*, which is a form of fibroma commonest in females, arises in the subcutaneous cellular tissue, usually of the extremities. It is firm, very tender, movable, rarely larger than a pea, and the skin over it seems healthy. Violent pain occurs in paroxysms and radiates over a considerable area of which the tubercle is the centre. These paroxysms may occur only once in many days or many times in one day. Nerve-fibrillæ have never been found in these tubercles.

Fibrous epulis is a fibroma arising from the gums or peri-odontal membrane (Bland Sutton) in connection with a carious tooth or retained snag; it is covered by mucous membrane, grows slowly, may attain a large size, and sometimes has a stem, but is more often sessile. It may undergo myxomatous change or may become sarcomatous. Fibrous tumors may arise from the ovary, the intestine, and the larynx. Pure fibromata of the uterus are very rare, but fibromyomata are very common (see *Myomata*, p. 204); hence the term "uterine fibroid" should be abandoned.

Molluscum fibrosum is an overgrowth of the fibrous tissue of both skin and subcutaneous structure. It may be limited or widely extended; it may appear as an infinite number of nodules scattered over the entire body or as hanging folds of fibrous tissue in certain areas. *Keloid* is a hard fibrous growth arising in scar-tissue; it is crossed by pink, white,

or discolored ridges, and is named from a fancied likeness to the crab. It is more common in negroes than in whites, and is most frequent in the cicatrices of burns, though it may arise in the scar of any injury, as the scar from piercing the ears, and in the scars of syphilitic lesions, small-pox, or vaccination. It is rare in early childhood and in old age. It grows slowly, lasts for many years, and may eventually undergo involution and disappear.

Morphœa, or spontaneous keloid, is a name used to designate a growth of this description which does not arise from a scar; but it seems certain that scar-tissue was present, though possibly in small amount from trivial injury.

Treatment.—Enucleate fibromata; do not let them remain, as any fibrous tumor might become a sarcoma. Epulis requires the cutting away of the entire mass, the removal of the related snag or carious tooth, and sometimes the biting away of a portion of the alveolus with a rongeur forceps. Keloid should not be operated upon: it will only return, and will also recur in the stitch-holes. Trust to time for involution, or use pressure with flexible collodion, by which method Prof. DaCosta cured a case following small-pox.

Chondromata (enchondromata) are tumors formed either of hyaline cartilage, of fibro-cartilage, or of both. Chondromata are apt to occur in the long bones, the pelvis, the rib-cartilages, and the bones of the hands or feet, and often spring from unossified portions of epiphyseal cartilage. They may be single or multiple, are often nodulated, and are most commonly met with in the young. They have distinct adherent capsules; they grow slowly, progressively hollowing out the bones by pressure; they cause no pain; they impart a sensation of firmness to the touch, unless mucoid degeneration forms zones of softness or fluctuation; they are inelastic, smooth or nodular, immovable, and often ossify. Chondromata may grow to an enormous size. A chondroma of the

parotid gland or testicle always contains sarcomatous elements, and any chondroma may become a sarcoma. Chondromata are notably frequent in persons who had rickets in early life. *Ecchondroses*, which are "small local overgrowths of cartilage" (Bland Sutton), arise from articular cartilages, especially of the knee-joint, and from the cartilages of the larynx and nose. Loose or floating cartilages in the joints may be broken-off ecchondroses or portions of hyaline cartilage which are entirely loose or are held by a narrow stalk, and which arise by chondrification of villous processes of the synovial membrane; only one or vast numbers may exist; one joint may be involved, or several; they may produce no symptoms, but usually produce from time to time violent pain and immobility by acting as a joint-wedge.

Treatment.—Remove chondromata whenever possible, for, if allowed to remain undisturbed, they are apt to resent this hospitality by becoming sarcomatous. Incise the capsule and take away the growth, using chisels and gouges if necessary. Incomplete removal means inevitable recurrence. Amputation is very rarely demanded. Loose bodies in the joints, if productive of much annoyance, are to be removed, the joint being opened with the strictest antiseptic care.

Osteomata.—Bland Sutton says that osteomata are ossifying chondromata. Compact osteomata, which are identical in structure with the compact tissue of bone, occur in the frontal sinus, mastoid process, external auditory meatus, and in other regions in those beyond middle life; they are small, capped with cartilage, smooth, round, with small, occasionally cartilaginous bases, and are densely hard.

Cancellous osteomata, which comprise the great majority of bone-tumors, are similar in structure to cancellous bone. They spring from, and are crusted with, cartilage; they may have fibrous capsules, and are often movable when recent,

but soon become fixed; they have a broad base, are angled, nodular, firm (but not so hard as are the compact osteomata), painless except by pressure, occur particularly at the ends of long bones, may grow to large size, and are commonest in youth. Osteomata near joints become overlaid by bursæ which in rare instances communicate with their related joints.

The term *exostosis* has been used as being synonymous with osteomata, but wrongly so, as an exostosis is an irregular, local, bony growth which does not tend to progress beyond a certain point, and which is hence not a tumor. A true exostosis is seen in the ossification of a tendon-insertion, in a limited growth from the maxillary bones, and in a local growth from the last phalanx of the big toe, which growth is known as a "sub-ungual exostosis." The bony masses sometimes found in the brain, lungs, testicle, various glands, and tumors are not true osteomata.

Treatment.—Osteomata which are non-productive of pain or trouble do not demand removal. If they produce pain by pressure, if they press upon important structures, if they produce annoying deformities, or if they grow rapidly, then remove them by means of chisels, gouges, or by the surgical engine. Exostosis of the toe should always be removed, to do which the nail should be split and part of it taken away, and the bony mass be gouged away or be cut off with forceps.

Odontomata[1] are tumors composed of tooth-tissue and springing from the germs of teeth or from developing teeth. Bland Sutton divides them into (1) those springing from the follicle; (2) those springing from the papilla; and (3) those springing from the whole germ.

Epithelial odontomes, or *multilocular cystic tumors*, arise from the follicle, occur oftenest in the lower jaw, dilate the bone, have capsules, and are made up of masses of cysts

[1] This section is abridged from Bland Sutton's striking chapter upon odontomes in his recent work on *Tumors*.

which are filled with brown fluid. These cysts are met with most frequently before the age of twenty. *Follicular odontomes*, or *dentigerous cysts*, oftenest spring from the follicles of the permanent molars. In a dentigerous cyst there exists an expanded follicle which distends the bone, the follicle being filled with thick fluid and containing a portion of a tooth. A *fibrous odontome* is due to thickening of the tooth-sac, thus preventing eruption of the tooth; fibrous odontomes are usually multiple, and are apt to occur in rickety children. A *cementome* is due to enlargement, thickening, and ossification of the capsule, the developing tooth being encased in cement. A *compound follicular odontome* is due to ossification of portions only of an enlarged and thickened capsule, and the tumor contains bits of cementum, portions of dentine, or small misshapen teeth. A *radicular odontome* springs from the papilla and arises after the crown of the tooth is formed and while the roots are forming; hence it contains dentine and cement, but no enamel. *Composite odontomes* are formed of irregular shapeless masses of dentine, cement, and enamel. All the above forms occur in man. They present themselves as hard tumors associated with teeth or in an area where teeth have not erupted. They may distend the jaw. Occasionally an odontome simulates necrosis; it is surrounded by pus, and a sinus forms.

Treatment.—The diagnosis is scarcely ever made until after incision; hence, be in no haste to excise large portions of bone for a doubtful growth; incise first and see if it be an odontome, which requires only the removal of an implicated tooth, curetting with a sharp spoon, and packing with iodoform gauze.

Myxomata are tumors composed of mucous tissue. The tissue type of these tumors is found in the vitreous humor of the eye and in the perivascular tissues of the umbilical

cord. Bowlby states that myxomata are in reality soft fibromata whose intercellular substance has been replaced by mucin. Myxomata may result from myxomatous degeneration of cartilage, of muscle, or of fibrous tissue. These tumors are soft, elastic, usually pedunculated, tremulous, and vibratory. Cutting into them causes a straw-colored fluid to exude; they grow slowly, have but little circulation, and their diagnosis may be impossible before removal. Some pathologists place myxomata among the malignant tumors, but most consider them as benign tumors, though they tend strongly to become sarcomatous (myxosarcomata). A sarcoma may undergo myxomatous degeneration.

Myxomata may arise from the skin; from the mucous membrane of the nose, the frontal sinus, the antrum, the womb, and the tympanum (gelatinous polyps); from the parotid and mammary glands; from the subcutaneous tissue, the nerve-sheaths, the intermuscular septi, the rectum, and the bladder (polyps).

Nasal polypi grow from the mucous membrane over the turbinated bones; they are soft and jelly-like, of a grayish color, and have stems or pedicles; they may be seen through the anterior nares, may project behind the veil of the palate, and may bulge out the passages of the nose; they may be, and usually are, multiple; they may be present in one nasal fossa or in both; and they occur most commonly in young adults.

Hydatid moles of pregnancy are due to myxomatous changes in the chorion.

Treatment.—In treating myxomata, remove them whenever possible. Nasal polyps may be twisted off or be removed by the wire snare or galvano-cautery.

Lymphomata are tumors composed of lymphatic-gland structure, and are due to multiplication of pre-existing adenoid tissue. Lymphomata are most frequently encoun-

tered in the neck and axillæ, and one gland or many may be involved; they grow rapidly and attain a large size; they are painless, are encapsuled, and are freely movable beneath the skin; they do not infiltrate surrounding tissues, and present no thickening from inflammation; they are commonest between the ages of twenty and thirty-five, but they may occur in early life. Gross states that the enlargement usually begins upon one side of the neck, gland after gland being successively attacked; in from four to eighteen months the glands of both sides of the neck, the axillæ, the bronchi, and the mesentery become involved, the patient's health fails, and death soon ensues. These tumors are said not to be malignant, but certain it is that they tend to recur after removal. It is impossible to distinctly separate this disease from lymphadenoma: they probably are related, or possibly are identical. Sarcoma of a lymphatic gland arises later in life than does lymphoma; it infiltrates surrounding structure, rendering the growth immovable, and implicates the related glands only, gluing them together; the tumor is painful and the skin ulcerates. Lymphoma differs from tubercular lymphadenitis in many ways. It originates in an apparently healthy person, it has no tendency to suppuration, the growths do not infiltrate, they remain movable, and the overlying skin retains a healthy appearance.

Treatment.—If possible, entirely extirpate a lymphoma; but if complete removal is impossible, perform no operation. In inoperable cases order cod-liver oil and nutritious diet, insist an open-air exercise, employ inunctions of ichthyol, give courses of arsenic in advancing doses, and from time to time administer iodide of potassium and iron in some form. Fowler's solution as an injection into the growth finds some advocates.

Myomata are tumors composed of unstriped muscle-fibre mixed often with fibrous tissue (leiomyomata). Tumors

composed of striated muscle-fibre (rhabdomyomata) are very rare and are always sarcomatous. Leiomyomata are found in the womb, in the prostate gland, in the walls of the gullet, vagina, stomach, bladder, and bowel, in the broad ligament, ovary, and round ligament, in the scrotum, and in the skin. Myomata usually begin during or after middle age; they are encapsuled, they grow slowly, they are firm and hard, and they produce annoyance by their size and weight or by obstructing a viscus or channel. A leiomyoma of the posterior and middle of the prostate forms "a middle lobe."

The so-called "uterine fibroid" is a myoma or fibromyoma. Uterine myomata may originate within the walls of the womb (intramural myomata), from the muscular structure of the mucous lining (submucous myomata), or from the muscular tissue of the serous covering (subserous myomata). Intramural uterine myomata may be single or be multiple and may grow to an enormous size. Submucous myomata project into the cavity of the womb (fleshy polyps). Submucous myomata distend the uterus and are often accompanied by menorrhagia or metrorrhagia; they may project into the vagina. In some rare cases the projecting tumor is detached by nature and the patient is cured; in other cases the myoma becomes gangrenous. This form of tumor may produce inversion of the fundus of the womb. Subserous uterine myomata cause trouble only by the inconvenience of weight or the discomfort of pressure. Uterine myomata may undergo fatty, calcareous, or myxomatous change, and may be infected by septic organisms as a result of the use of a uterine sound or of infection of the pedicle after oöphorectomy. Infection of a uterine myoma causes great enlargement, elevated temperature, sweats, and exhaustion. Uterine myomata, which are commonest in single women (Bland Sutton), arise most frequently between the ages of

twenty-five and forty-five. They may never produce any symptoms; some, by enlarging until they ascend above the pelvic brim, produce abdominal distention; some become jammed or impacted in the pelvis, and produce by pressure retention of urine, obstruction to passage of feces, or hydronephrosis. Impaction may occur temporarily at each menstrual period. Many myomata produce uterine hemorrhage; some cause retroversion of the womb; some protrude from the cervical canal; some are so large that they cause disastrous pressure upon the colon (constipation), upon the iliac veins (intense œdema), or upon the ureters (hydronephrosis). Uterine myomata usually shrink after the menopause. Pregnancy in a myomatous womb usually ends in abortion.

The symptoms of myomata of the alimentary canal are similar to or identical with the symptoms of malignant growths. Myomata of the skin are rare growths; they are encapsuled, firm or elastic, and painless.

Treatment.—Cutaneous myomata are removed in the same manner as fatty tumors. Uterine myomata are treated by rest, ergot, barium chloride, and dilute sulphuric acid. If this treatment fails to arrest serious bleeding due to a fleshy polyp, dilate the cervical canal and remove the growth. If there be dangerous bleeding in a woman who has some years to wait for the menopause and who has not a removable polyp as the cause, perform oöphorectomy in order to bring on an artificial menopause. When a myoma becomes impacted at each menstrual period, remove the ovaries and Fallopian tubes. Hysterectomy is indicated for some very large tumors, for tumors that grow after the menopause, and for infected myomata. If the abdomen be opened to perform oöphorectomy, and the tubes and ovaries are found so implicated in the growth that they cannot be removed completely, or the broad ligament is found so drawn out that a

safe pedicle cannot be secured, perform a hysterectomy.[1] A recent suggestion for the shrinkage of uterine myomata is to ligate both the uterine and ovarian arteries. If a myoma of the prostate causes severe obstruction, effect a suprapubic cystotomy and remove the major portion of the enlarged gland.

Neuromata.—A true neuroma springs from nerve-tissue (brain, cord, or nerve-trunks); it is composed of medullated or non-medullated nerve-fibres which form a plexus or network and which are not continuous with the fibres of the nerve-trunk or other area from which the tumor grows. True neuromata, which are rare growths, arise during middle life; they are small in size, are due to injury or hereditary tendency, and they may be single or multiple. There is usually around the tumor, rather than in it, severe neuralgic pain, which is greatly intensified by dampness, by blows, or by rough handling. The parts below a neuroma are cold, swollen, often anæsthetic, and frequently present motor paralysis or trophic disorder. A false neuroma or neuro-fibroma is a tumor growing from a nerve-sheath, and is identical in structure with the sheath. False neuromata may be single, but they are often multiple; they may be as small as peas or as large as oranges; they are smooth and movable, and may cause great pain or may only hurt when pressed or struck; they may spring from roots, trunks, or branches, and they may be linked with the disease known as "molluscum fibrosum." In plexiform neuroma some branches of a nerve enlarge and lengthen like an artery in a cirsoid aneurysm; the mass feels like beads or like a bag of worms; it is mobile, and no pain is felt on moving it; and it is generally congenital. In plexiform neuroma the nerve-sheath undergoes myxomatous change. Malignant

1 See Bland Sutton's admirable article on "Uterine Myomata" in his work on *Tumors*.

neuroma means primary sarcoma of a nerve-sheath, though any neuroma may become sarcomatous.

Traumatic neuromata are occasionally well exhibited after nerve-section or amputation. On nerve-section the distal end shrinks and atrophies, the proximal end enlarges and becomes bulbous. These traumatic neuromata are composed of fibrous tissue which contains nerve-fibres; they are usually, but not always, painful on pressure or during dampness, and they are commonest in stumps which did not heal by first intention. Painful subcutaneous tubercle is considered under the head of Fibromata.

Treatment.—A false neuroma is to be removed, if possible, without destroying the nerve-trunk. If, in removing a neuroma, it is necessary to exsect a portion of a nerve-trunk, always endeavor to suture the ends so as to facilitate restoration of function. For multiple neuromata—at least should the number be large or should molluscum fibrosum exist—surgery can do nothing. Plexiform neuromata may often be removed, but amputation may be required. Painful neuromata in stumps should be excised.

Angeiomata.—These vascular or erectile tumors are growths composed of blood-vessels.

Simple or *capillary angeiomata*, or "mother's marks," which affect the skin or subcutaneous tissue, are composed of enlarged and twisted capillaries and of anastomosing vessels surrounded by fat. These growths are congenital or appear in the first few weeks of life; they are of a bright-pink color if composed chiefly of arterioles, and are bluish if composed mainly of venules; they are but little elevated; they can be almost completely emptied by pressure; they occasionally pass away spontaneously, but usually grow constantly and may become cavernous; they may ulcerate and occasion violent or fatal hemorrhage. One or several large vessels join a nævus to adjacent blood-vessels. Port-wine or claret

stains are pink or blue discolorations due to superficial nævi of the skin; they may be small in extent or they may involve a very large area, and are not elevated. Teleangeiectasis is a form of nævus involving the skin and subcutaneous tissue in which many arterioles and venules exist. Simple angeiomata are common on the forehead, the scalp, the face, the neck, the back, and the extremities. They may appear on the labiæ, the tongue, or the lips.

Cavernous angeiomata resemble in structure the corpora cavernosa of the penis; there are large spaces with thin walls carrying blood, and there may be distinct vessels as well. Arteries send blood into the spaces, and veins receive it from the spaces. These channels and sinuses are enormously distended capillaries. Cavernous angeiomata arise in the skin and subcutaneous tissues; they are usually congenital, but may develop from simple angeiomata. These cavernous angeiomata are purple or blue in color, are distinctly elevated, and are apt to pulsate; they may be emptied by pressure, and often look like cysts with very thin walls. Cavernous angeiomata may arise in the breast, the tongue, or the muscles. If an angeioma contains an excess of fat, the growth is called a "nævoid lipoma."

Plexiform angeiomata are known as "cirsoid aneurysms" or aneurysms by anastomosis (see p. 231).

Treatment.—Small port-wine stains can be removed by electrolysis, but extensive stains are ineffaceable. Small nævi may be ligated under hare-lip pins; larger nævi may be strangulated with the Erichsen suture or may be completely excised. Excision is the best plan for the cure of the cavernous variety of angeiomata. Do not use astringent injections.

Lymphangeiomata are tumors composed of dilated lymph-vessels, and are usually, though not invariably, congenital. The lymphatic nævus is a colorless or faintly pink elevation;

if it is punctured with a needle, lymph flows from the puncture. One or several nævi may be present in the same individual. Local lymphangeioma of the tongue is manifested by a cluster of papillary projections containing lymph. Macroglossia is a congenital enlargement of the anterior portion of the tongue, which enlargement grows more and more marked until finally the tongue is forced far out of the mouth. This condition of tongue-enlargement is due to lymphangeioma of the mucous membrane. Just as there occur cavernous angeiomata among blood-vessel tumors, there occur cavernous lymphangeiomata among lymph-vessel tumors, and the spaces are filled with lymph instead of with blood.

Treatment.—Lymphatic nævus requires excision. In macroglossia remove the bulk of the mass by a V-shaped cut and so stitch the mucous membrane as to close the stump.

Malignant Connective-tissue Tumors, or Sarcomata.—The sarcomata are composed of embryonic tissue. They develop from connective tissue, have no definite stroma, and contain no lymphatics. The rapidly-growing forms are very vascular, the blood flowing in vessels whose walls are very thin or running in canals whose boundaries are sarcomatous cells. These tumors may pulsate and have a bruit, and hemorrhages often take place in their substance. Slow-growing sarcomata have but few vessels. Sarcoma disseminates by means of the blood and the vessel-walls, particles of sarcoma being carried by the venous blood to the heart and from this organ to the lungs, where they lodge and form secondary growths. Emboli from this secondary focus are sent out by the arterial blood to various portions of the body, as the bones, kidneys, brain, liver, etc. This process is known as "metastasis." Sarcoma follows the vein-walls for considerable distances and builds elongated masses inside the veins. Sarcoma tends strongly to infiltrate adjacent

parts. The tumor may possess a capsule when it is in an early stage, but soon loses this except in very slow-growing or mixed forms growing by central proliferation. Sarcomata may arise at any age from birth to extreme senility, but they are commonest during youth and early middle age. They are not hereditary, and often follow contusion. They may arise from malignant change in an innocent connective-tissue growth (chondrosarcoma, fibrosarcoma, etc.). A sarcoma does not tend to affect lymphatic glands except by the accident of its position, and if it does implicate them, the sarcomatous elements are carried rather by the vein-walls and blood than by the lymph (melanotic sarcoma implicates adjacent glands, and so does sarcoma of the tonsil or of the testicle). The skin over the tumor may give way, a bleeding fungus-mass protruding (fungus hematoides), and suppuration may cause septic enlargement of adjacent glands. After removal of a sarcoma the growth tends to recur, and the recurrent tumor may be either more or less malignant than its predecessor, the degree of malignancy being in direct ratio to the number and smallness of the cells. A sarcoma is malignant by local tissue-infection and by dissemination. Sarcomata rarely cause pain when they are not ulcerated. Sarcomata are commonest in the skin and connective tissue of the extremities, but they arise also from bone, neuroglia, periosteum, in the lymphatic glands, the breast, the testicle, the eye, the parotid, and in other parts. Hemorrhages into a sarcoma often occur, with the result of suddenly increasing its size and forming blood-cysts. Sarcomata are subject to partial fatty degeneration, to myxomatous changes which produce cavities filled with fluid, to calcification, and occasionally to necrosis of large masses.

Species of Sarcomata.—The following species of sarcomata are recognized :

1. Round-celled, in which the matrix is soft and vascular. The cells may be small or may be large. The smaller the cell the more malignant the growth. A small round-celled sarcoma is the most malignant variety of sarcoma and is soft in consistence.

2. Spindle-celled, which are composed of bundles of spindle-cells lying in a matrix which may be homogeneous, but which may show some attempt at fibre-formation. Rhabdomyoma is a variety of spindle-celled sarcoma containing striated muscle-cells. These spindle-celled sarcomata often contain cartilage.

3. Mixed-celled sarcoma, containing both of the above varieties of cells.

4. Giant-celled or myeloid, which contains some round cells, some spindle-cells, and large cells with many nuclei, like the cells of bone-marrow. It is maroon colored on section. This is the least malignant form of sarcoma, and it sometimes admits of complete extirpation and cure. It tends to occur in the long bones as a central sarcoma.

5. Alveolar, in which the cells are collected in alveoli as are the cells of cancer. It arises usually from a mole.

6. Melanotic, which may be composed of either round cells or spindle-cells containing a black pigment.

7. Lympho-sarcoma, which is composed of small round cells held in a delicate network, the tissue somewhat resembling that of a lymphatic gland.

Clinical Varieties of Sarcoma.—The following are the clinical varieties of sarcoma:

Melanotic or *black sarcoma*, the color of which is due to pigment in the cells or matrix. These growths are usually round-celled, but may be spindle-celled; they are sometimes alveolar, and spring from parts which contain pigment (skin and choroid coat of the eye); they are apt to arise from pigmented moles; they are very malignant;

they implicate related lymphatic glands, and during their existence the urine contains pigment.

Glio-sarcoma is a sarcoma of neuroglia. A pure glioma is composed of adult connective tissue; but, as a matter of fact, pure glioma almost never arises, and the growth practically always contains numerous small round cells and is properly a sarcoma. It springs from the neuroglia of the central nervous system, and is usually of about the consistence of the cortex of the brain; it is generally single, and does not cause secondary growths. A gliomatosis of the cord produces that remarkable disease known as "syringomyelia." The symptoms of glioma of the brain depend upon its situation.

Hemorrhagic sarcoma is a sarcoma containing blood-cysts, the results of parenchymatous hemorrhages.

Cylindroma, or Plexiform Sarcoma.—In this variety the cells adjacent to vessels have undergone hyaline degeneration; cells distant from vessels are unchanged. Section shows the normal cells apparently contained in spaces with hyaline walls.

Mixed tumors consist partly of mature and partly of embryonic tissue, the cellular elements exceeding the adult elements in amount. Among these mixed tumors are fibro-sarcoma or the recurrent fibroid tumor, myxo-sarcoma, chondro-sarcoma, and osteo-sarcoma.

Treatment of Sarcomata.—Remove a sarcoma at once if it is in an accessible spot. Never delay removal. Cut well clear of it. The rapidly-growing soft sarcomata will almost inevitably return, and the very malignant variety, if uninterfered with, may terminate life in six months; but operation postpones the evil day and renders it possible that death will occur from metastasis in an organ, and that the patient will escape the horrors of ulceration and hemorrhage from the original tumor. Slowly-growing and hard tumors offer some prospects of cure. The mixed tumor (as a recurrent

fibroid) may repeatedly recur, and yet the patient may be cured at last by a sixth, an eighth, or a tenth operation. In sarcomata of the long bones amputation should, as a rule, be performed, though in some cases of giant-celled sarcomata excision can be employed. In sarcomata of the jaw-bones, excision; of the eye, enucleation; and of the testicle, castration, are demanded. Sarcoma of the ovary in adults demands ovariotomy, but in children the operation is useless. Sarcoma of the kidney in adults calls for nephrectomy, but in children the operation is of no avail. In melanotic sarcoma remove the growth and adjacent lymph-glands, or in some cases amputate. Removal of a sarcoma when there is no hope of a cure is often justifiable to prolong life, to relieve the patient of a foul, offensive, bleeding mass, and to permit of an easier road to death by means of metastasis to an internal organ. Wright advocates internal treatment for sarcoma and for cancer. He advises that bromide of arsenic be given for a long period of time, the dose being gr. $\frac{1}{40}$ to gr. $\frac{1}{10}$ after each meal. Before meals gr. x of carbonate of lime are advised. This treatment, Wright holds, should be used before, and for many months after, operation, as an aid to surgery. In inoperable cases it may be tried.[1]

It has been observed that an attack of erysipelas occasionally greatly benefits a sarcoma, causing large masses of the growth to soften or to slough and expose a granulating surface. It has been suggested that in inoperable cases of sarcoma this condition might be established artificially. A bouillon culture is made of the streptococci; this culture is filtered through porcelain and is injected once a day into and about the sarcoma. The first dose is ♏x, and it is increased; it should cause a febrile reaction, and sometimes establishes softening or suppuration. The exact status of this plan is not determined; it has improved or possibly

[1] *Annals of Surgery*, April, 1893.

cured some cases, but is not free from danger.[1] The injection of aniline products into the sarcoma, which has received a qualified commendation from some observers, has been abandoned by Profs. Keen and White after careful trial.

Innocent Epithelial Tumors.—These growths imitate an epithelial tissue of the mature and healthy organism.

Papillomata, or Warts.—These growths are formed upon the type of cutaneous and mucous papillæ. A papilloma consists of a fibrous stroma which contains blood-vessels and lymphatics and which is covered by epithelium of the variety appertaining to the diseased part. Warts grow from the skin and from mucous membranes; they may be single or multiple; they may be painless or may be ulcerated and bleeding; great masses may gather around the anus, the vagina, or the penis during the existence of a filthy discharge, and crops appear on the hands of those who work in irritant material (as petroleum). A large crop of warts may disappear in a single night; hence the popular belief in the efficacy of charms. A single wart may reach a large size and become pigmented. The squamous epithelium covering a skin-wart may become horny (a wart-horn). Other cutaneous horns arise from the nails, from the scars of burns, or from ruptured sebaceous cysts.

Villous papillomata grow chiefly from the bladder; they form tufts like the villous processes of the chorion; they may be single or multiple, and may be sessile or pedunculated; they are very vascular, and are apt to bleed freely. Papillomata may arise in cysts of the paroöphoron, in cysts of the mammary gland, and from the choroid plexuses of the ventricles of the brain. A villous papilloma of the choroid plexus early calcifies and becomes converted into a psammoma. Psammomata of the spinal membranes may arise. Any papilloma may become a cancer.

[1] See Coley, in *American Journal of Medical Sciences* for May, 1893.

Treatment.—Venereal warts are treated by repeatedly washing with peroxide of hydrogen, drying with cotton, and dusting with a powder composed of equal parts of calomel and subnitrate of bismuth, or oxide of zinc and iodoform, or borated talcum. If they do not soon dry up, cut them off with scissors and burn with the Pacquelin cautery. Ordinary warts may usually be destroyed in a short time by daily applications of lactic or chromic acid. Keeping a wart constantly moist with castor oil will often cause it to drop off. Warts, and even extensive callosities, may be removed by painting once a day for five days with pure carbolic acid and covering with lint kept wet with boracic acid. A convenient plan is to paint a wart daily with a solution containing 1 part of corrosive sublimate to 30 parts of collodion (hydrarg. chlor. corros., ʒss; collodion, ʒvij et ss). Large warts should be freely excised. Villous papillomata of the bladder demand the performance of a suprapubic cystotomy in order to remove them. Psammomata cannot be diagnosticated until the growth is exposed.

Adenomata.—These glandular tumors are composed of tissue identical with that of normal glands, and they may contain acini and ducts like racemose glands or tubes like tubular glands. They grow from secreting glands, but cannot produce the secretion of the glands from which they spring, or, if they do secrete, the fluid is retained, and not discharged by the gland-duct. Adenomata occur in the mammary gland, the parotid, the ovary, the thyroid gland, the liver, the sweat-glands, and the prostate, and as pedunculated growths from the mucous lining of the intestine and uterus. They are encapsuled, are usually single, but may be multiple, are of slow growth, but may attain a great size; they do not tend to recur after thorough removal, do not involve adjacent glands, and do not disseminate; they are firm to the touch; they tend to become cystic (especially in

the thyroid), the fluid which distends the ducts being due to mucoid liquefaction of the proliferating epithelium.

In the breast a fibro-adenoma has a distinct capsule; it is elastic and movable, is usually superficial, and one occasionally exists in each gland. They are most common before the age of thirty, and are often painful, especially during menstruation. Cystic adenomata of the breast attain a large size; they are encapsuled and grow slowly, are most common after the thirtieth year, and are rarely painful. Both fibro-adenoma and cystic adenoma may arise in the male breast. Young unmarried women not unusually develop in the breast small, very tender, and painful bodies, most usually around the edge of the areola, which bodies increase in size and become more tender during menstruation, and which are only cysts of the mammary tissue.

Adenomata of the thyroid gland begin before the fifteenth year (Gross). Adenomata may arise in the prostate if that gland be already the seat of senile hypertrophy. Adenoma of mucous glands may arise in the young or the middle-aged.

Treatment.—Adenomata require extirpation. By confusing adenomata of the mammary gland with small cysts of that structure an erroneous belief has arisen that the former, as well as the latter, may sometimes be cured by the local use of iodine, mercury, and ichthyol and the internal use of iodide of potassium. The treatment is excision. It would be as easy to dissolve off a rooster's comb by iodide of potassium as by it to absorb an adenoma.

Malignant Epithelial Tumors, Carcinomata, or Cancers.—Cancers are tumors growing from epithelial surfaces, and are composed of epithelial cells which are clustered in spaces, nests, or alveoli of fibrous tissue. The cells of a cluster are not separated by any stroma, and the walls of the alveoli carry blood-vessels and lymphatics. Cancers are always

derived from epithelium (of glands, of skin, of mucous membrane, etc.), and if found in a non-epithelial tissue must be secondary. They have no capsules, rapidly infiltrate surrounding tissues, are firmly anchored and immovable. In the beginning a cancer is a local lesion, but it soon attacks related lymph-glands and by means of the lymph is disseminated throughout the system, secondary growths arising which are identical with the parent growth. Cancer is rare before the age of forty, and never occurs before puberty; seems occasionally to be hereditary; is sometimes linked with continued irritation as a cause (cancer of the penis in phimosis; cancer of the lip from the hot stem of a clay pipe; chimney-sweeps' cancer from soot in the scrotal folds); is often the seat of pricking pain; tends strongly to recur after removal; is prone to ulcerate, causing pain, hemorrhage, and cachexia; makes rapid progress, and is often fatal in from one to two and a half years. It is more common in women than in men, and rarely exists with tubercle. After a cancer has existed for a time in an important structure, or after a superficial cancer has ulcerated and become hemorrhagic, there is noted in the individual evidences of illness and exhaustion. We speak of this condition as the "cancerous cachexia," and in it the muscles are wasted, the body-weight is constantly diminishing, the complexion is sallow, the face is sunken, pearly white conjunctivæ contrast strongly with the yellow skin, the pulse is weak and rapid, and night-sweats add to the exhaustion. The above condition is due to pain, loss of sleep, bleeding, deprivation of exercise, mal-assimilation of food, and anxiety. Cancer may kill by obstructing a canal, by destroying the functions of a viscus or organ, by hemorrhage, by anæmia, by sepsis, or by exhaustion.

Classification of Carcinomata.—Carcinomata are classified as follows: 1. Squamous-celled cancer, or epithelioma; 2. Rodent ulcer, or Jacob's ulcer; 3. Spheroidal-celled cancer

(*a*, scirrhus; *b*, encephaloid; *c*, colloid); and 4. Cylindrical-celled cancer.

Epitheliomata.—An epithelioma may arise wherever there is pavement epithelium, and it is especially apt to appear at the junctions of skin and mucous membrane (as the lips) or the point of juxtaposition of different kinds of epithelium. In epithelioma there is an ingrowth of surface epithelium into the sub-epithelial connective tissue, colonies of cells growing inward and forming epithelial nests. It may arise without discoverable cause, it may follow prolonged irritation, or it may arise in a wart or fissure. In the nipple it is often preceded by a persistent eczema, due probably to psorosperms and known as *Paget's disease.* Epithelioma generally begins as a warty protuberance which soon ulcerates. The malignant ulcer has a hard, irregular base, uneven edges, a foul, fungus-like bottom, and it gives off a sanious or ichorous discharge. This ulcer is the seat of sharp pricking pain, sometimes bleeds, and extends over a considerable area, embracing and destroying all structures. Epithelioma affects lymphatic glands, usually early, but its action may be delayed for eight or ten months. These glands break down in ulceration, making frightful gaps and often causing fatal hemorrhage. Dissemination is not nearly so common as in other forms of cancer, but it does sometimes occur.

A *rodent* or *Jacob's* ulcer is scarcely ever met with except upon the face, it being especially common upon the nose and forehead. It begins after the age of forty as a little warty prominence which ulcerates in the centre, the ulceration progressing at a rate equal to the new growth, and sometimes healing temporarily at one spot while it extends at another. Jacob's ulcer grows slowly, may last for years, does not involve the lymphatics, produces no constitutional cachexia, and is rarely fatal. It is an ulcer with irregular edges and a smooth base of a grayish color, its discharge being thin and

acrid, and is considered to be a malignant epithelial growth which springs from a sweat-gland, a sebaceous gland, or a hair-follicle. The base of the ulcer is hard, which differentiates it from lupus (Hearn.) From lupus the bacilli of tubercle may be cultivated.

Spheroidal-celled Carcinomata.—(*a*) *Scirrhous cancer* is a white and fibrous mass which has no capsule, which infiltrates tissues, and which draws in toward it, by the contraction of its outlying processes, adjacent soft parts, thus producing dimpling, or, as in the breast, retraction of the nipple. It is composed of spheroidal cells in alveoli formed of connective-tissue bands. The commonest seat of scirrhus is the female breast. It occurs also in the skin, vagina, rectum, prostate, uterus, stomach, and œsophagus. It is most frequent in women after forty. It begins as a hard lump which is at first painless, but soon becomes the seat of an acute localized pricking pain. This lump grows and becomes irregular and adherent, causing puckering of the soft parts. After the skin or mucous membrane above it has become infiltrated ulceration takes place and a fungous mass protrudes to bleed and to suppurate. The adjacent lymphatics soon become involved, and the constitutional involvement is rapid and certain.

(*b*) *Encephaloid cancer* is a soft gray or brain-like mass. It is a rare growth, it has no capsule, and it may appear in the kidney, liver, ovary, testicle, mammary gland, stomach, bladder, and antrum. An encephaloid often contains cavities filled with blood, and this variety is known as a "hematoid" or a "telangiectatic" carcinoma. These growths are soft and semi-fluctuating, they infiltrate rapidly and soon fungate, and they terminate life in from a year to a year and a half. If the cells of encephaloid become filled with melanin, we have the condition known as "melanosis" or "melanotic cancer."

(*c*) *Colloid cancer* arises from either a scirrhus or an encephaloid cancer when the cells or stroma undergo colloid degeneration. On section we see in the centre of the growth a series of cavities filled with a material resembling honey or jelly; the periphery often shows an ordinary scirrhus or encephaloid cancer. Colloid degeneration is most prone to attack cancers of the stomach, mammary gland, and intestine.

Cylindrical-celled carcinomata which occur in the rectum are known as "adenoid" or "glandular" cancers. They may occur in this region at a much earlier age than do cancers elsewhere, being not uncommon between the ages of twenty-eight and forty. At first covered by mucous membrane, they soon ulcerate and involve the submucous and muscular coats in the growth. They grow rather slowly, and take usually from four to six years to kill. They usually, but not always, cause lymphatic involvement and constitutional infection. They are composed of a stroma of fibres between which lie tubular glands lined with columnar epithelium and masses of epithelial cells.

Treatment.—Carcinomata demand early and free excision with removal of implicated glands. A certain proportion can be cured. Recurrent growths may be removed as a palliative measure, to lessen pain and to relieve the patient from ulceration and hemorrhage. If a growth does not recur within five years after removal, a cure has probably been attained. A rodent ulcer should be excised or else be curetted and cauterized with the hot iron or the Pacquelin cautery. In cancer of the *lip*, remove a V-shaped piece; in cancer of the *tongue*, excise this organ; in cancer of the *breast*, remove the breast and pectoral fascia and take away the fat and glands of the axilla; in cancer of the *rectum*, if near the surface, excise the rectum from below; if above five inches from the anus, do the sacral resection of Kraske; in

cancer of the *œsophagus*, perform gastrostomy; in cancer of the *pylorus*, perform pylorectomy or gastro-enterostomy; in cancer of the *bowel*, do resection with anastomosis, side-track the diseased area by an anastomosis, or make an artificial anus; in cancer of the *penis*, amputate.

Cysts.—A cyst is a sac containing a fluid or a semi-fluid.

Division of Cysts.—Cysts are divided into (1) *Retention-cysts*, which are due to blocking up of the excretory ducts of glands and accumulation of the glandular secretions. These comprise sebaceous cysts or wens, serous cysts, mucous cysts, salivary cysts, milk-cysts, oil-cysts, and seminal cysts. (2) *Exudation-cysts*, which are due to accumulations in closed cavities. These comprise synovial cysts (ganglions and bursæ) and dentigerous cysts. (3) *Dermoid cysts*, which are congenital and arise from inversion of the cutis and imperfectly closed fœtal clefts. (4) *Cystomas*, which are cysts of new formation due to cystic degeneration of connective tissue. These cysts are found in the neck (hygroma), in the arm-pit, and in the perineum. An example of a cystoma is found in the bursa which will develop from pressure. (5) *Extravasation-cysts*, that form around blood-extravasations. (6) *Hydatid cysts*, or cysts due to the echinococcus or tapeworm of the dog. A mother-cyst is formed, which becomes filled with daughter-cysts floating in a saline liquor containing hooklets.

Sebaceous cysts arise when the excretory duct of a sebaceous gland is blocked by dirt or occluded by inflammation. The orifice of the duct is often visible as a black speck over the centre of the cyst. They are very common in the scalp, where they are known as "wens," and upon the face, neck, shoulders, and back. Arising in the skin, and not under it, the skin cannot be freely moved over them, though a large cyst must extend into the deeper tissues. A sebaceous cyst is lined by epithelium and is filled with

foul-smelling sebaceous material. A sebaceous cyst may suppurate.

Treatment.—To treat a sebaceous cyst, dissect it entirely away with scissors or an Allis dissector, trying not to rupture the sac. If even a small particle of it is left, the cyst will return. If it ruptures during removal and it is feared that some portion may remain, swab out the wound with pure carbolic acid. If acid is not used, close without drainage, but if acid is used, drain for twenty-four hours. If an abscess has formed, open it. Grasp the edges of the cyst-lining with forceps, dissect out this lining with scissors curved on the flat, cauterize with pure carbolic acid, and drain for twenty-four hours.

Dermoid cysts are lined with true skin. They contain sebaceous matter, hair, teeth, or other epiblastic products. They are always congenital, but may be so small at birth as to escape notice for years. They may be distinguished from sebaceous cysts by the fact that they always lie below the deep fascia, and hence the skin is freely movable over them. They are met with at the root of the nose, at the orbital angles, in the eyelids, upon the floor of the mouth, over the sacrum or coccyx, and in the ovaries, the testicles, the brain, the eyes, the mediastinum, the lungs, the omentum, the mesentery, and the carotid sheaths. They are due to imperfect closure of fœtal clefts and inclusion of epiblast. If a dermoid cyst contains bones, it shows that mesoblast was included as well as epiblast.

Treatment.—To treat a dermoid cyst, excise, if accessible, the same as in the case of a sebaceous cyst. If it lies over bone, go down to the bone: the growth will be found adherent, so remove a portion of periosteum with the cyst (Hearn).

Hydatid cysts occur particularly among people who live shut up with dogs, as is the case in Iceland. The parasite is

swallowed with the food and is taken up by the stomach-veins, and penetrates the intestine and peritoneum to find a nest in some neighboring or distant organ or tissue. Open these cysts, scrape, asepticize, and pack with iodoform gauze.

XVII. DISEASES AND INJURIES OF THE HEART AND VESSELS.

Heart and Pericardium.—In an acute pulmonary congestion the venous side of the heart is over-distended with blood, and the surgeon in desperate cases may tap the right auricle (see *Paracentesis auriculi*). Pericardial effusion, if severe, calls for tapping or aspiration, and purulent pericarditis demands incision and drainage.

Wounds and Injuries.—The heart may rupture and cause instant death, but slight wounds may not prove fatal. A wound of the heart causes hemorrhage, usually copious, but, owing to the interlocking of muscular fibres, the hemorrhage is often slight. If bleeding into the pericardal sac takes place, the signs of a pericardial effusion become manifest. Pain is constant, and attacks of syncope are the rule. Death is apt to occur suddenly from shock, hemorrhage, and inability of the heart to contract because of the severed fibres, or inability of the heart to dilate because of the pressure of blood in the pericardial sac. If a wound of the pericardium or heart does not cause death in the first day or two, inflammation follows (traumatic pericarditis or carditis).

Treatment.—The treatment of heart-wounds consists of recumbency and the lowering of the head. The body is surrounded with hot bottles, opium is given in small doses, and stimulants are applied in moderation, but never to excess. Traumatic carditis or pericarditis is treated in the same way as idiopathic cases.

Phlebitis, or Inflammation of a Vein.—Phlebitis may be *plastic* or it may be *purulent.* Plastic phlebitis, while occasionally due to gout, to a febrile malady, or to some other constitutional condition, usually takes its origin from an injury, from the extension to the vein of a perivascular inflammation, or from a thrombus or an embolism. When phlebitis begins a thrombus forms because of the destruction of the endothelial coat, and this clot may be absorbed or organized. Suppurative phlebitis is a suppurative inflammation of a vein, arising by infection from suppurating perivascular tissues. It is most frequently met with in cellulitis or phlegmonous erysipelas, and may arise in the lateral sinus as a result of mastoid suppuration. A thrombus forms, the vein-wall suppurates, is softened and in part destroyed, and the clot becomes purulent. No bleeding occurs when the vein ruptures, as a barrier of clot keeps back the blood-stream. The clot of suppurative phlebitis cannot be absorbed and cannot organize. Septic phlebitis may cause pyæmia, and the infected clots of pyæmia may cause phlebitis.

Symptoms.—The symptoms of phlebitis are pain, tenderness in and around a vein, discoloration over it, and solid œdema below the seat of the disease. Suppurative phlebitis causes the constitutional symptoms of infection.

Treatment.—The treatment of phlebitis comprises rest in bed, elevation of the part, the administration of tincture of iron, and, locally, lead-water and laudanum. Hot fomentations are used later in the case. Abscesses are opened, asepticized, and drained. Internal treatment is symptomatic (opium, stimulants, etc.). When a vein is involved in this process, ligate, if possible, above and below the clot, open the vessel, and wash out the purulent mass. This is always to be done in infective thrombo-phlebitis of the lateral sinus.

Varicose Veins, or Varix.—*Definition and Causes.*—Varicose veins are unnaturally and permanently dilated veins

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which elongate and pursue a tortuous course. The causes of varicose veins are obstruction to venous return and weakness of cardiac action, which lessens the propulsion of the blood-stream.

Varicose veins are chiefly met with on the inner side of the lower extremity, in the spermatic cord, and in the rectum. Varix in the leg is met with during and after pregnancy and in persons who stand upon their feet for long periods. It especially appears in the long saphenous, which, being subcutaneous, has no muscular aid in supporting the blood-column and in urging it on. The deep as well as the superficial veins may become varicose.

Varix of the spermatic cord is known as "varicocele." It is apt to appear about the time of puberty, and most adult men have at least a slight varicocele. Varix is more likely to appear in the left spermatic vein than in the vein of the right side, because the left spermatic vein has no valves (Brinton).

Varix of the veins of the rectum is known as "hemorrhoids" or "piles," which are caused by obstruction to the upward flow in the hemorrhoidal veins, either by obstructive liver disease, enlargement of the uterus or prostate, or the presence in the rectum of fecal masses in a person habitually constipated.

A vein under pressure usually dilates more at one spot than at another, the distention being greatest back of a valve or near the mouth of a tributary. The valves become incompetent and the dilatation becomes still greater. The vein-wall may become fibrous, but usually it is thin and often ruptures. The veins not only dilate, but they also become longer, and hence do not remain straight, but twist and turn into a characteristic form. Varicose veins are apt to cause œdema, and the watery elements in the tissues cause eczema of the skin. When eczema is once inaugurated, excoriation

is to be expected. Infection of an excoriated area produces inflammation, suppuration, and an ulcer.

The skin over varicose veins in the leg is often discolored by pigmentation due to the red blood-cells having escaped from the vessel and broken up. The tissues around a varicose vein become atrophied from pressure, and there is often met with a very large vein whose thin walls are in close contact with skin. In this condition rupture and hemorrhage are probable. Varicose veins are apt to inflame, and thrombosis frequently occurs.

Treatment.—The treatment of varix may be *palliative* or *curative.* In palliative treatment, attend to the general health, keep up the force and activity of the circulation, and prevent constipation. Recommend the patient to exercise in the open air and to lie down, if possible, every afternoon. Locally, in varix of the leg, order a flannel roller or a Martin rubber bandage to support the veins and drive the blood into the deeper vessels which have muscular support. Locally, in varicocele, pour cold water upon the scrotum twice a day and order the patient to wear a suspensory bandage. Locally, in hæmorrhoids, use astringent suppositories. The curative or radical treatment of varix of the leg comprises ligation with excision of part of the vein, exposure and ligation of the vein, multiple subcutaneous ligatures of catgut, acupressure-pins with twisted sutures, or injection of pure carbolic acid into the perivascular structures (see *Operations upon Vessels*).

Nævus.—(See *Tumors.*)

Arteritis, or inflammation of an artery, is *acute* or is *chronic.*

Acute arteritis may result from injury or from extension of inflammation from the perivascular tissues. This latter mode of origin is uncommon, as arteries are very resistant to the spread of inflammation, but we meet with it sometimes in suppurating areas. In a suppurating acute arteritis the

coats ulcerate through, but hemorrhage rarely occurs unless a considerable portion of the vessel sloughs. Septic emboli lodging in the arterial system produce acute arteritis. This is seen during the progress of ulcerative endocarditis.

Chronic arteritis produces "atheroma." It is due to increase of blood-pressure from hard work, strains, heart disease, or contracted kidney. It is especially common in drunkards and in the larger arteries. It is commonest in the aged, but may be met with in young drunkards. It is a true saying that "A man is as old as his arteries." In chronic arteritis exudation of serum and leucocytes takes place beneath the intima, which coat, in consequence, is swelled out, and a like exudation soon becomes manifest in the media, in the adventitia, and even in the sheath. Embryonic tissue is formed, which may undergo resolution, may become fibrous tissue (arterial sclerosis), or may undergo fatty degeneration (atheroma). When fatty degeneration occurs the endothelium is destroyed, the vessel-wall is damaged, and the blood obtains access to the deeper coats. Calcareous change may follow fatty degeneration.

An atheromatous artery is rigid and inelastic, and the parts it supplies are cold, congested, and ill-nourished. Atheroma is a frequent cause of thrombosis, aneurysm, senile gangrene, and apoplexy. Syphilitic arteritis is characterized by an enormous growth of granulation tissue from the inner coats (obliterative arteritis) of arteries of small size. Calcification of an artery may be secondary to fatty change or may occur primarily from deposit of lime salts in the middle coat. Periarteritis is inflammation of the sheath and outer coat. An acute arteritis is always local, but a chronic arteritis may be general.

Treatment of acute arteritis consists of rest, elevation and relaxation, the application of tincture of iodine, and the use of lead-water and laudanum. Hot fomentations are applied

later. Abscesses are opened and drained. Internally, treat any diathesis (rheumatic, gouty, or syphilitic), maintain kidney secretion, quiet the circulation, and employ a non-stimulating diet. The part must be kept quiet, as rough movement would tend to rupture the vessel.

Treatment of Chronic Arteritis.—In treating chronic arteritis, endeavor to antagonize the dangers to which the patient is obviously liable. Stop alcohol as a beverage, though a little whiskey may be taken at meals to aid digestion. Maintain the activity of the skin by daily baths, and of the kidneys by diuretic waters. The contents of the bowels are to be kept soft. The diet is to be plain and is to contain a minimum of nitrogen. If syphilis has existed, occasional courses of iodide are to be urged. If the arterial tension at any time becomes inordinately high, give nitroglycerin. One danger is apoplexy; hence excitement and violent exercise are to be avoided. Another danger is senile gangrene; hence the patient should wear woollen stockings, put a hot bottle to his feet at night, and be careful to avoid injuring his toes or feet, especially when cutting his corns. When a patient with atheroma has dyspnœa and is of a livid color, or when the arterial tension is very high, a moderate blood-letting (sixteen to eighteen ounces) does good. Still another danger is aneurysm, which may appear suddenly from rupture or gradually from progressive distention.

Aneurysm.—An aneurysm is a pulsating sac containing blood and communicating with the cavity of an artery. Some restrict the term "true aneurysm" to a condition of dilatation involving *all* the coats of the vessel. We shall consider, with Heath, a *true* aneurysm to be that in which the blood is included in one or more of the arterial coats, and a *false* aneurysm to be that in which the vessel has ruptured or has atrophied and the aneurysmal wall is formed by a condensation of the perivascular tissues.

Forms of Aneurysm.—The following forms of aneurysm are recognized:

1. *True aneurysm*—one whose sac is formed of one or more arterial coats.

2. *False aneurysm*—one whose sac is formed of condensed perivascular tissues and contains no arterial coat.

3. *Traumatic aneurysm*—a false aneurysm due to traumatic rupture some time before, the blood being in a sac of tissue and all wound being healed.

4. *Fusiform aneurysm*—a variety of true aneurysm, the sac being spindle-shaped.

5. *Consecutive aneurysm*—a sacculated aneurysm diffused by rupture, or a false aneurysm due to gradual destruction or atrophy of a true aneurysmal sac or to vascular rupture.

6. *Sacculated aneurysm*—a common form of aneurysm, in which the dilatation is like a pouch, arising from a part of the arterial circumference and joining the lumen of the vessel by an aperture.

7. *Dissecting aneurysm*—a pouch-like dilatation, due to the blood which, passing through an aperture in the intima, enters between the media and adventitia and dissects them apart. It may or may not join the lumen of the artery at another point by a fresh aperture in the intima.

8. *Arterio-venous aneurysm*, which is divided into aneurysmal varix, or Pott's aneurysm, where there is direct communication between a vein and an artery, and varicose aneurysm, where there is communication between an artery and a vein by means of an interposed sac.

9. *Acute aneurysm*—a cavity in the walls of the heart, which cavity communicates with the interior of this organ, and which is due to suppuration in the course of acute endocarditis or myocarditis.

10. *Aneurysm by anastomosis.*—(See *Angeiomata.*)

11. *Aneurysm of bone*—a clinical term to designate a pulsatile tumor of bone.

12. *Circumscribed aneurysm*—when the blood is circumscribed by distinct walls.

13. *Cirsoid aneurysm*—a mass of dilated and elongated arteries shaped like varicose veins and pulsating with each heart-beat.

14. *Cylindrical aneurysm*—a dilatation of the same dimensions for a considerable space.

15. *Embolic* or *capillary aneurysm*—dilatation of terminal arteries due to emboli.

16. *Spontaneous aneurysm*—non-traumatic in origin.

17. *Miliary aneurysm*—a minute dilatation of an arteriole.

18. *Secondary aneurysm*—one which, after apparent cure, again pulsates, the blood entering by means of the anastomotic circulation.

19. *Verminous aneurysm*—one containing a parasite. This form of aneurysm is met with in the mesenteric artery of the horse.

The sac of a sacculated aneurysm is at first composed of at least two of the arterial coats, reinforced by the sheath and perivascular tissues. After a time the blood-pressure distends the sac, and the inner and middle coats either stretch with interstitial growth or—what is more common—are worn away and lost. When all the coats are lost, and the blood is sustained only by the sheath and surrounding tissue, a true aneurysm becomes a diffused or consecutive aneurysm, the limiting tissues and sheath being condensed, thickened, and glued together. This limiting process is deficient in the brain; hence cerebral aneurysms break soon after their formation. When all the arterial coats are lost, the blood-pressure, acting on the tissues, finds some spots less resistant than others, the blood follows the lines of least resistance, the aneurysm grows with great rapidity, and soon ruptures.

An aneurysm may rupture into a cavity (pleura, pericardium, or peritoneum), into the perivascular tissues, or through the skin. Rupture into the tissues may produce pressure-gangrene. When rupture occurs through the skin, the hemorrhage is not often instantly fatal, but is during days constantly recurrent in larger and larger amounts. The pressure of an aneurysmal sac causes atrophy of tissues, hard and soft, bones and cartilages being as easily destroyed as muscles and fat. Sometimes the perivascular tissues inflame and suppurate, and the sac is opened rapidly by sloughing. An aneurysm usually progresses toward rupture, the slowest in this progression being the fusiform dilatations, which may exist for many years, but which finally eventuate in the sacculated variety.

In some rare instances there takes place spontaneous cure, which may result from laminated fibrin being deposited upon the walls of the sac as the blood circulates through it. This laminated fibrin is known as an "active clot," and eventually fills the sac. The weaker and slower the blood-stream, the greater is the tendency to the formation of an active clot; hence any agent impeding, but not abolishing, the circulation aids in the deposition. This weakening and slowing of circulation may be brought about by great activity of the collateral circulation deviating most of the blood away from the area of disease. Sometimes a clot breaks off from the sac-wall and plugs the artery beyond the dilatation, and the anastomotic vessels, enlarging, divert the blood-stream. A large aneurysm, falling over by its own weight upon the vessel above the mouth of the sac, may diminish the blood-stream. The development of another aneurysm upon the same vessel weakens the circulation in the older one. Inflammation occasionally forms a clot. The tissues about an aneurysm tend to contract when arterial force is lessened; hence tissue-pressure may more

than counteract blood-pressure when the circulation is feeble. Clotting of the blood contained within a sac, circulation through the aneurysm having ceased, causes a passive clot. A passive clot, which occasionally cures, may arise from a twisting of the neck of the sac, preventing the passage of blood; from the lodgment of a clot in the mouth of the sac; and from inflammation. Spontaneous cure is, unfortunately, very rare.

Causes of Aneurysm.—Gradual distention of arterial coats which are in a condition of arterial sclerosis, or local loss of resisting power due to atheroma, may cause aneurysm. Hence the causes of sclerosis and atheroma are also causes of aneurysm. The principal cause of aneurysm is increased blood-pressure. This increase may be brought about by severe labor; by sudden strains, as in lifting; by violent efforts, as in rowing in a boat-race; by chronic interstitial nephritis; by hypertrophy of the heart; by alcoholic inebriety; and by syphilis. Arterial disease is commonest in the larger vessels and in the aged, but it may occur in youth. When an aneurysm follows a strain, it may be due to laceration of the media and loss of resistance at a narrow point. The intima may lacerate, permitting the blood to come in contact with the media or causing it to diffuse between the coats (dissecting aneurysm). An embolus may cause an aneurysm on its proximal side. The embolus, if infective, causes softening, and if calcareous causes laceration (Osler). Colonies of micrococci may cause aneurysm.[1] The parasite *strongylus armatus* causes aneurysm of the mesenteric arteries in horses. Suppuration around a vessel weakens its coats and tends to aneurysm by inducing acute arteritis and softening. Some people develop many aneurysms the origins of which are lost in mystery.

The constituent parts of an aneurysm are (1) the wall of

[1] See Osler on *Malignant Endocarditis.*

the sac; (2) the cavity; (3) the mouth; and (4) the contents.

Symptoms of Aneurysm.—A pulsatile tumor exists, which instantly ceases to pulsate and almost or entirely disappears on making firm pressure on the artery above. On relaxing the pressure the pulsatile enlargement at once reappears. Direct pressure upon the tumor causes it to almost or entirely disappear. Pressure upon the artery below causes the tumor to enlarge. The pulsation is expansile—that is, it expands in all directions—and if an index finger be laid on each side of the tumor so that their points nearly touch, each pulsation not only lifts the fingers, but it also separates them. On placing a stethoscope over the aneurysm there is imparted to the ear a distinct bruit which travels in the direction of the blood-stream and is systolic in time. In internal aneurysms pressure-symptoms are marked. Thoracic aneurysm causes intercostal pain; iliac aneurysm causes pain in the thigh. Aneurysm of the aorta presses upon the pneumogastric nerve, causing spasmodic dyspnœa, and upon the recurrent laryngeal, causing loss of voice and paralysis of all the muscles of the larynx except the crico-thyroid. The pulse below an aneurysm is weaker than the pulse of a corresponding part of the opposite limb. This is well shown by the sphygmograph, the tracings being rounded without a sudden rise or an abrupt fall (Pl. 1, Figs. 5, 6).

Diagnosis.—A cyst or abscess over a vessel may show transmitted pulsation which is not expansile, and the tumor does not disappear on pressure above it. There is no true bruit, and the history is widely different. A growth under a vessel may lift the vessel and simulate an aneurysm, but the pulsation is not noted in the entire growth, the growth does not disappear on proximal pressure, and there is only a false, and never a true, bruit. The larger the growth the less is the pulsation due to pressure upon the vessel. A

sarcoma, especially a soft sarcoma attached to the bone, pulsates and often has a bruit; it never disappears from proximal pressure, though it may slowly diminish in size, to gradually enlarge again when pressure is withdrawn. An aneurysm may cease to pulsate from consolidation leading to cure, or from rupture. Rupture of a large aneurysm into a cavity induces deadly pallor, syncope, and rapid death. Rupture of an aneurysm of an extremity into the tissues is made manifest by a sensation of something breaking, by pain, by sudden increase in size, by absence of bruit and pulsation, by absence of pulse below the aneurysm, by swelling and coldness of the limb, and by shock.

Treatment.—In inoperable aneurysms *general, medical, and dietetic* treatment must be tried. It consists chiefly in rest in bed to diminish the rapidity and force of the circulation and favor fibrinous deposit. Tufnell's plan is to reduce the heart-beats by rest and mental quiet, and to rigidly restrict the diet so as to diminish the total amount of blood and render it more fibrinous. Liquids are restricted in amount, and the patient lives for twenty-four hours upon four ounces of bread, a very little butter, eight ounces of milk, and three ounces of meat. Pursue this plan for several months if possible, or employ it for several weeks at a time over and over again. There can be no doubt that Tufnell's treatment sometimes cures by decidedly lowering the blood-pressure. Valsalva long ago suggested rest, occasional bleeding, and a diet just above the point of starvation. In many cases of aneurysm the patient may be permitted to go about, taking his time about everything and avoiding work, worry, and excitement. The diet is low and non-stimulating, and the bowels must be maintained in a loose condition.

Iodide of potassium in doses of 20 grains undoubtedly does good, and not only in syphilitic cases. It seems to lower the blood-pressure. Balfour taught that it thickened

the sac. Osler says it relieves the pain. Iron, acetate of lead, and ergotine are prescribed by some. Digitalis is contraindicated, as it raises the blood-pressure. Morphia and bromide of potassium are occasionally useful to tranquillize the circulation, allay pain, or secure sleep. Aconite and veratrum viride have long been employed. Other expedients are: the kneading of the sac to release a clot, in the hope that it will plug the mouth of the sac or the artery beyond it—this is dangerous; electricity; electrolysis; the injection of an astringent liquid; the insertion of a fine aspirating-needle and the pushing through it into the sac of a large quantity of silver wire, in the hope that it will aid in whipping out fibrin. Some physicians have inserted needles and horse-hair.

Even in an operable case diet and rest are of importance. The patient should be in bed for a number of days before operation, the daily diet consisting of ten or twelve ounces of solid food with a pint of milk. If the circulation is very active, use aconite and allay pain by morphia.

Treatment by Pressure.—Instrumental pressure is made by applying two Signorini tourniquets or some specially-devised apparatus to limit the flow of blood through an aneurysm without entirely stopping it, the aneurysmal sac being felt to still slightly pulsate. These instruments can be worn for from twelve to sixteen hours at a time, usually removing them to permit sleep and reapplying them the next day, and so on for several days. This method may cure, but it is very painful. It aids in the formation of an active clot.

Digital pressure, made with the thumb aided by a weight, and maintained for many hours by a relay of assistants, has cured many cases. It entirely cuts off the blood and promotes the formation of a passive clot.

Direct pressure upon the sac has been used in aneurysm of the popliteal artery, the pressure being obtained by flexing

the leg; and in aneurysm of the brachial artery pressure has been obtained at the bend of the elbow by flexing the elbow. The pressure of a hollow rubber ball has been used in aneurysm of the subclavian.

Rapid pressure completely arrests the passage of blood through the sac for a limited time, and is applied while the patient is under the influence of an anæsthetic. Take, for example, a case of popliteal aneurysm: the patient is placed under ether; two Esmarch bandages are used, one being put on the limb from the toes to the lower limit of the aneurysm, and the other from the groin down to the upper limit of the sac, and the Esmarch band is fastened above the upper bandage. This procedure stagnates the blood both in the veins and in the arteries, the sac remaining full of blood. Pressure is thus maintained for three or four hours, and on removing the Esmarch apparatus a tourniquet is put on the artery above the aneurysm and partly tightened to limit the amount of blood passing through and thus prevent the washing away of clot. This method of rapid pressure sometimes cures by forming a passive clot, but it sometimes results in gangrene.

Operative Treatment: By the Ligature.—Ligation of the main artery is, as a rule, the best procedure. The methods of ligation are—(1) the method of Antyllus; (2) the method of Anel; (3) the method of Hunter; (4) the method of Wardrop; and (5) the method of Brasdor.

In the *method of Antyllus* the sac itself is attacked. Hemorrhage is controlled by the Esmarch bandage, the sac is opened, its contents turned out, and the artery ligated immediately above and below the sac. This method is only employed for traumatic aneurysms, as its use in aneurysms from diseased vessel-walls would mean that the ligatures were almost surely applied upon diseased areas (Fig. 31).

The Method of Anel.—In Anel's method the artery is

ligated close to and above the sac (Fig. 32). It is only used for traumatic aneurysms, and is never employed when the vessel is diseased.

The Method of Hunter.—This operation, which is the modern method of ligation, was devised by the illustrious

FIG. 31.—Old Operation of Antyllus for Aneurysm (*Am. Text-Book of Surgery*).

FIG. 32.—Anel's Operation for Aneurysm (*Am. Text-Book of Surgery*).

John Hunter. He recognized the fact that the vessel adjacent to an aneurysm was apt to be diseased, and he discovered the anastomotic circulation. Putting together these two facts, he devised the operation which goes by his name. It consists in applying a ligature between the heart and the aneurysm, but so far above the sac that collateral branches are given off between it and the point of ligation (Fig. 33). This operation, which is done upon a healthy area, does not

FIG. 33.—Hunter's Operation for Aneurysm (*American Text-Book of Surgery*).

at once cut off all blood, but so diminishes the force and frequency of the circulation that an active clot forms within the sac. Thus is lessened the danger of secondary hemorrhage and of gangrene. It is, as a rule, the proper operation for aneurysm. In some cases pulsation does not return after tightening the ligature; in most cases, however, it reappears for a time after about thirty-six hours, but is weak and constantly diminishing. Previous prolonged compres-

sion by enlarging the collateral branches permits strong pulsation to soon recur after ligation, and thus militates against cure; hence it is a bad plan to use pressure in cases where its success is very uncertain.

Distal Ligation.—When an aneurysm is so near the trunk that Hunter's operation is impracticable, or when the artery on the cardiac side of the tumor is greatly diseased, distal ligation can be employed. Distal ligation forms a barrier to the onflow of blood, collateral branches above the aneurysm enlarge, the blood-current is gradually diverted, and a clot is formed. Distal ligation is used in some aneurysms of the aorta, iliacs, innominate, carotids, and subclavians.

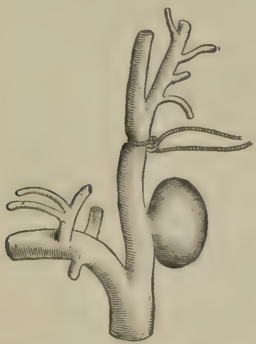


FIG. 34.—Brasdor's Operation (Holmes).

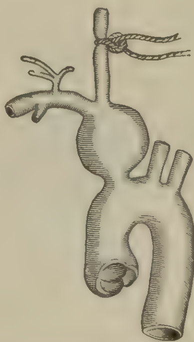


FIG. 35.—Wardrop's Operation (Holmes).

The operation of Brasdor consists in tying the main trunk some little distance below the aneurysm (Fig. 34).

The operation of Wardrop consists in tying one of the branches of the artery below the aneurysm (Fig. 35).

After ligating for aneurysm by any of these methods, elevate the limb, keep it warm, and subdue arterial excitement. When moist gangrene follows ligation, amputate early, above the ligature. When dry gangrene takes place, await a line of demarcation. Rupture of the sac after liga-

tion may produce gangrene or suppuration, the first condition demanding amputation, and the second incision for drainage.

Amputation for aneurysm is performed in some perilous cases of subclavian aneurysm instead of distal ligation.

Electrolysis.—An attempt may be made to coagulate the blood at once, or from time to time an endeavor may be made to produce fibrinous deposits, but the first method is the better. It is, however, rarely possible to at once occlude a sac, and pulsation, which is for a time abolished, recurs as the gas present is absorbed. Use the constant current. Take from three to six cells which stand in point of size between those used for cautery and those used for ordinary medical purposes. A platinum needle is attached to the positive pole and a steel needle to the negative pole, both needles being insulated by vulcanite at the points where the skin will touch them. The asepticized needles are plunged into the sac where it is thick and they are kept near together. The current is passed for a variable period (from half an hour to an hour and a half). This operation is not dangerous. Pressure stops the bleeding. Electrolysis sometimes cures, and often ameliorates, aortic aneurysms.[1]

Acupressure consists of the partial introduction of a number of ordinary sewing-needles into an aneurysmal sac and leaving them in it for five or six days or more.

Introduction of Wire.—Insert into the sac a hypodermatic or small aspirating-needle, and push through the needle or canula a considerable quantity of aseptic silver wire, which is allowed to remain permanently. Loreta combines electrolysis with the introduction of wire.

Traumatic aneurysm is a condition in which, after puncture or rupture of an artery, a sac has formed of tissue, and if any wound previously existed, it has healed. The treatment consists in ligation by the method of Antyllus. When

[1] See John Duncan, in *Heath's Dictionary*.

an artery ruptures and a large mass of blood is extravasated, no sac exists, and it is an error to designate this condition as a diffuse traumatic aneurysm. There is no pulsation in the tumor nor in the arteries below it, and the limb is cold and swollen. If the main vein is also ruptured, or if the rupture has occurred into a large joint, amputate; otherwise perform the operation of Antyllus.

Arterio-venous aneurysm is an unnatural passage-way between a vein and an artery, through which passage blood circulates. There are two forms: (*a*) *aneurysmal varix*, where a vein and an artery directly communicate; and (*b*) *varicose aneurysm*, where vein and artery communicate through an intervening sac. These conditions arise usually from punctured wounds, the instrument passing through one vessel and into the other, blood flowing into the vein, the

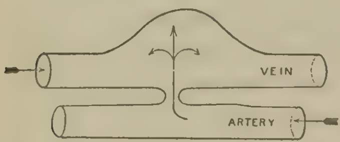


FIG. 36.—Plan of an Aneurysmal Varix (*American Text-Book of Surgery*).

FIG. 37.—Varicose Aneurysm (Spence).

subsequent inflammation gluing the two vessels together, and the aperture failing to close (aneurysmal varix, Fig. 36). After the infliction of the wound the two vessels may separate, the blood still flows from artery into vein, and the blood-pressure, by consolidating tissue, forms a sac of junction (varicose aneurysm, Fig. 37). Aneurysmal varix is a far less grave disorder than varicose aneurysm.

Symptoms.—In aneurysmal varix a swelling exists with the characteristic pulsation and a loud whirring bruit is transmitted along the veins. The veins above and below the tumor are enlarged, tortuous, and pulsating. A distinct thrill is felt. Pressure over the tumor stops the thrill and

greatly lessens the bruit. The extremity is apt to be swollen and the parts are usually painful. When pressure on the main artery causes the entire disappearance of the tumor, the case is one of aneurysmal varix; but if on applying this pressure the veins collapse and a distinct tumor remains which can be emptied by direct pressure, the case is one of varicose aneurysm. If light pressure on one spot stops both murmur and thrill, it is aneurysmal varix. The diagnosis between the two is often impossible.

Treatment.—Aneurysmal varix often requires only palliative measures, as it does not tend to rupture, the veins becoming thick and resistant and after a time ceasing to enlarge. Some form of support is used. If the part is painful or the veins promise rupture, tie the artery above and below the opening. Varicose aneurysm requires the use of the plans ordinarily adopted in treating aneurysm (compression, etc.). If these fail, tie the artery above and below the opening, but do not open the sac.

Cirsoid aneurysm, or **aneurysm by anastomosis,** consists in great dilatation with pouching and lengthening of one or several arteries. The disease progresses and after a time involves the veins and capillaries. The walls of the arteries thin and the vessels tend to rupture. Cirsoid aneurysm is met with upon the forehead and scalp of young people, where it sometimes takes origin from a nævus.

Symptoms.—A pulsating mass, irregular in outline, composed of dilated, elongated, and tortuous vessels that empty into one another. The mass is soft, can be much reduced by direct pressure, and is diminished by compression of the main artery of supply. A thrill and a bruit exist. Pregnancy and puberty cause a rapid growth of a cirsoid aneurysm.

Treatment.—In treating a cirsoid aneurysm the ligation of the larger arteries of supply is a wretched failure. Sub-

cutaneous ligation at many points of the diseased area has effected a cure in some cases, but it has failed in most. Direct pressure is also entirely useless. Ligature in mass has been successful. Destruction by caustic has its advocates. Electro-puncture with circular compression of the arteries of supply has once or twice effected a cure. Injection of astringents has been recommended. Verneuil ligated the afferent arteries, incised the tissues around the tumor, and sunk a constricting ligature into the cut. The proper method of treatment is excision after the subcutaneous ligation of every accessible tributary of supply.[1]

Wounds of arteries are divided into contused, incised, lacerated, punctured, and gunshot wounds, and vascular ruptures.

Contused and Incised Wounds.—A contusion may destroy vitality and be followed by sloughing and hemorrhage. A contused wound may do little damage, or it may produce gangrene from thrombus, or it may cause secondary hemorrhage. In an incised wound there is profuse hemorrhage. The artery after a time is apt to contract and retract, and thus arrest bleeding. A transverse wound causes profuse bleeding, but there is a better chance for natural arrest than in an oblique or in a longitudinal wound. In a partially-divided artery, cut it entirely through and tie both ends. The clot which forms in a cut artery is known as the "internal clot;" it reaches as high as the first collateral branch, and subsequently becomes organized permanently, obliterates the vessel, and converts it into a shrunken fibrous cord. Between the vessel and its sheath, over the end of the vessel, and in the surrounding perivascular tissues is the "external clot."

Lacerated wounds cause little primary hemorrhage. The internal coat curls up, the circular muscular fibres of the

[1] Anderson, in *Heath's Dictionary*.

media contract upon it, and the external coat is so pulled out as to cap the orifice of the vessel—all of which conditions favor clotting. The vessel-wall is so damaged that secondary hemorrhage is usual.

Punctured Wounds.—In punctured wounds primary hemorrhage is slight. Secondary hemorrhage is not usual. Diffuse aneurysm and arterio-venous aneurysm are not unusual results.

Gunshot wounds are apt to be contusions which may eventuate in sloughing and secondary hemorrhage or thrombosis and gangrene. A shell-fragment makes a lacerated wound. A rifle-bullet may make a clean-cut division of an artery. Secondary hemorrhage after gunshot wounds tends to occur during the third week. Partial rupture of an artery may cause sloughing and secondary hemorrhage, thrombosis and gangrene, and aneurysm. Complete rupture is a lacerated wound, and is a condition accompanied by diffuse traumatic aneurysm.

Wounds of veins are classified as are wounds of arteries. The *symptom* of any vascular wound is hemorrhage.

1. Hemorrhage, or Loss of Blood.

Hemorrhage may arise from wounds of arteries, veins, or capillaries, or from wounds of the three combined. In arterial hemorrhage the blood is scarlet and appears in jets from the proximal end of the vessel, which jets are synchronous with the pulse-beats; the stream, however, never intermits. The stream from the distal end is darker and is not pulsatile. Venous hemorrhage is denoted by the dark hue of the blood and by the continuous stream. In capillary hemorrhage red blood wells up like water from a sponge.

In subcutaneous hemorrhage from vascular rupture (diffuse aneurysm) there are great swelling, cutaneous discoloration, and systemic signs of hemorrhage. If an artery rup-

tures in an extremity, there is no pulse below the rupture. If a vein ruptures in an extremity, intense œdema occurs. Profuse hemorrhage induces constitutional symptoms, and death may occur in a few seconds. Generally, after the bleeding has gone on for a time syncope occurs, which is Nature's effort to arrest hemorrhage, for during this state the feeble circulation and the increased coagulability of the blood give time for the formation of a clot. When reaction occurs the clot may hold, or it may be washed away with a renewal of bleeding and syncope. These episodes may be repeated until death supervenes. Nausea and vertigo exist, black specks float before the eyes (muscæ volitantes), tinnitus aurium exists, delirium is not unusual, and convulsions often occur. After a profuse hemorrhage an individual is intensely pale and of a sort of greenish tinge; the eyes are fixed in a glassy stare and the pupils are widely dilated; the respirations are shallow and sighing; the skin is covered with a cold sweat; the legs and arms are extremely cold; the pulse is soft, small, compressible, fluttering, or often cannot be detected; the heart is very weak and fluttering; and there is musular tremor. When such a dangerous condition is due to a visible hemorrhage, temporarily arrest bleeding by digital pressure in the wound, lower the head, and have compression made upon the femorals and subclavians, so as to divert more blood to the brain. Apply artificial heat. Inject by hypodermoclysis the normal salt solution (10 to 16 ounces) into the cellular tissue of the buttock; inject ether hypodermatically, then brandy, and then strychnia in doses of gr. $\frac{1}{20}$. Atropia, digitalis, and morphia are recommended. Give enemata of hot coffee and brandy. Apply mustard over the heart and spine. As soon as reaction begins, arrest the bleeding permanently by the ligature.

Hemorrhagic Fever.—A profuse bleeding is apt to be fol-

lowed by fever—hemorrhagic fever—due to the absorption of fibrin ferment from extravasated blood and its action upon a profoundly debilitated system. In this form of fever there are most intense thirst, violent headache, dimness of vision, great restlessness, often mental wandering, with a very frequent, weak, and fluttering heart.

Treatment.—In treating a patient after a severe hemorrhage, apply cold to the head to prevent serous effusion into the brain. Aconite, morphia, and neutral mixture are given by the mouth. Fluids and ice are grateful. Frequently sponge the skin with alcohol and water (S. W. Gross). Milk punch, koumiss, and beef-peptonoids are given at frequent intervals. If the hemorrhage is from some spot inaccessible to ligation, such as the lung, give the patient 3 grains of gallic acid, 1 grain of powdered digitalis, 1 grain of ergotine, and ½ grain of powdered opium every three or four hours.

Hemostatic agents comprise (1) the ligature; (2) torsion; (3) acupressure; (4) compression; (5) styptics; (6) the actual cautery; and (7) forced flexion of limbs.

The ligature may be made of silk, floss-silk, or catgut, but it must be aseptic. The ligatures should be about ten inches long. The vessel is drawn out with forceps and separated from surrounding tissues. The forceps are better than the tenaculum in most cases, because the tenaculum makes a hole through which blood may subsequently exude. When the artery lies in hard tissues or is retracted deeply in muscle or fascia, the tenaculum is best. Tie with a reef-knot. The tightening of the first knot cuts the internal and middle coats; the second knot must not be tied too tightly, or it will cut the ligature. Do not jerk the ligature in tying, and cut it off close. Both ends of the vessel are tied. If an artery is incompletely divided, tie on each side of the cut and entirely sever the vessel between the ligatures. If a large vein is slightly torn, try pinching up

the vein-walls around the rent and apply a ligature (lateral ligature). If the bleeding comes from an artery very close to its point of origin, tie the main trunk as well as the bleeding branch, otherwise the clot formed will be too short and secondary hemorrhage will be inevitable. When the parts about an artery are so thickened that the artery cannot be drawn out, arm a Hagedorn needle (Fig. 38) with catgut and so pass the latter around the vessel that the catgut will include the vessel with some of the surrounding tissue, and tie the ligature. This method is pursued in necrosis, atheroma, scar-tissue, sloughing, etc. Never include a nerve. If this mode of ligation fails, try acupressure.

FIG. 38.—Hagedorn Needles.

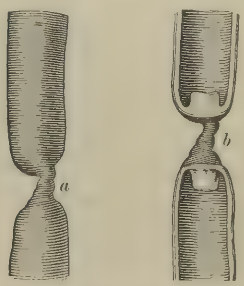


FIG. 39.—Torsion in Continuity (Bernard and Huette).

Torsion.—By means of torsion the internal and middle coats are ruptured and the external coat is twisted. It is a safe procedure, and is practised by many surgeons of high standing upon vessels as large as the femoral. Torsion has the signal merit of not introducing possible infection in ligatures. The vessel is drawn out by one pair of forceps, and another pair is applied transversely half an inch above the cut end and twisted six or eight times. Figure 39 *a*, *b* shows torsion in continuity.

Acupressure is pressure with a pin. A pin is simply passed under a vessel (transfixion), leaving a little tissue on each side between the pin and vessel. A needle can be passed under a vessel, and a wire be thrown over the needle and twisted (circumclusion). The needle can be inserted upon one side, passed through half an inch of tissues up to the vessel, be given a quarter-twist, and be driven into the tissues across the artery (torsoclusion). Some tissue is picked up on the needle, folded over the vessel, and pinned to the other side (retroclusion). Acupressure is used for inflamed or atheromatous vessels, in sloughing wounds, and where a ligature will not hold.

Compression is either direct or indirect—that is, in the wound or upon its artery of supply. In the removal of the upper jaw, arrest bleeding by plugging. In injury of a cerebral sinus, plug with gauze. Compression and hot water (120°) will stop capillary bleeding. A graduated compress is often used in hemorrhage from the palmar arch. A compress will arrest bleeding from superficial veins. The knotted bandage of the scalp will arrest bleeding from the temporal artery. Long-continued pressure causes pain and inflammation.

Styptics.—Chemicals are now rarely used. In epistaxis we may pack with plugs of gauze saturated in antipyrine. In bleeding from a tooth-socket, pack with styptic cotton (absorbent cotton soaked in Monsel's solution and dried). In bleeding from an incised urinary meatus, pack with styptic cotton. Cold water or ice acts as a styptic by producing reflex vascular contraction. Hot water produces contraction and coagulates the albumen. The temperature should be from 115° to 120° F. A mixture of equal parts of alcohol and water stops capillary oozing.

The actual cautery is a most ancient hemostatic. It is still used in some cases after excising the upper jaw, in

bleeding after the removal of some malignant growths, in continued hemorrhage from the prostatic plexus of veins, after lateral lithotomy, and to stop oozing after the excision of venereal warts. We are driven to it in "bleeders"—that is, those persons who have a hemorrhagic diathesis, and who may die from having a tooth pulled or from receiving a scratch. It will arrest hemorrhage, but sloughing is bound to occur, and when the slough separates secondary hemorrhage is apt to set in. The iron for hemostatic purposes must be at a black heat.

Forced flexion is a variety of indirect compression. It will stop bleeding, but soon becomes intensely painful.

Golden Rules for Procedure in Primary Hemorrhage.—1. In arterial hemorrhage, tie the artery in the wound, enlarging the wound if necessary. In tying the main artery of the limb in continuity we fail to cut off the bleeding from the distal extremity, and hemorrhage is bound to recur. If we fail to look into the wound, we cannot know what is cut: it may be only a branch, and not a main trunk. The same rule obtains in secondary hemorrhage (Guthrie's rule).

2. Ligate veins as we would arteries.

3. In a wound of the superficial palmar arch, tie both ends of the divided vessel.

4. In a wound of the deep palmar arch, enlarge the wound, if necessary, in the direction of the flexor tendons, at the same time maintaining pressure upon the brachial artery. Catch the ends of the arch with hemostatic forceps and tie both ends. If the artery can be caught by, but cannot be tied over the point of, the forceps, leave the instrument on for four days. If the artery cannot be caught with forceps, try a tenaculum. If these means fail, insert a small piece of gauze in the depth of the wound, put over this a larger piece, and keep on adding bit after bit, each one larger than its predecessor, until there is constructed a conical pad the

apex of which is against the extremities of the cut arch and the base of which is well external to the palm. Bandage each finger and the thumb, put a piece of metal over the pad, put a compress in front of the elbow, flex the forearm upon the arm, wrap the hand in gauze, place the arm upon a straight splint, apply firmly an ascending spiral reverse bandage of the arm, starting as a figure-of-8 of the wrist, and hang the hand in a sling. The pad is left in place for six or seven days unless bleeding keeps on or recurs. If bleeding is maintained or begins again, ligate the radial and ulnar. If this manœuvre fails, we know that the interosseous artery is furnishing the blood and that the brachial must be tied at the bend of the elbow. If this fails, amputate the hand.

5. In primary hemorrhage, if the bleeding ceases, do not disturb the parts to look for the vessel. If the vessel is clearly seen in the wound, tie it; otherwise do not, as the bleeding may not recur. This rule does not hold good when a large artery is probably cut, when the subject will require transportation (as on the battle-field), when a man has delirium tremens, mania, or delirium, or when he is a heavy drinker. In these cases always look for an artery and tie it.

6. When a person is bleeding to death, arrest hemorrhage temporarily by digital pressure in the wound and apply above the wound a tourniquet or Esmarch bandage. Bring about reaction and then ligate, but do not operate during collapse if the bleeding can be controlled by pressure.

7. If an artery be divided incompletely, put a ligature on each side of the vessel-wound and then sever the artery so as to permit of complete retraction.

8. If a branch comes off just below the ligature, tie the branch as well as the main trunk.

9. If a branch of an artery is divided very close to a main trunk, tie the branch and also the main trunk. If the

branch alone be tied, the internal clot, being very short, will be washed away by the blood-current of the larger vessel.

10. If a large vein is slightly torn, put a lateral ligature upon its wall. Gather the rent and the tissue around it in a forceps and tie the pursed-up mass of vein-wall.

11. When a branch of a large vein is torn close to the main trunk, tie the branch, and not the main trunk. Apply practically a lateral ligature.

12. If, after tying the cardial extremity of a cut artery, the distal extremity cannot be found even by a careful search after enlarging the wound, firmly pack the wound.

13. In bleeding from diploë or cancellous bone, use Horsley's antiseptic wax.

14. In bleeding from a vessel in a bony canal, plug the canal with an antiseptic stick and break the wood, or fill up the orifice of the canal with antiseptic wax; or, if this fails, ligate the artery of supply.

15. In bleeding from the internal mammary artery, pass a large curved needle holding a piece of silk into the chest, under the vessel and out again, and tie the thread tightly.

16. In bleeding from an intercostal artery, make pressure upward and outward, or throw a ligature by means of a curved needle entirely over a rib, tying it externally, or resect a rib and tie the artery.

17. In collapse due to puncture of a deep vessel, the bleeding having ceased, do not hurry reaction by stimulants. Give the clot a chance to hold. Wrap the sufferer in hot blankets. If the condition is dangerous, however, stimulate to save life.

18. In punctured wounds, as a rule, try pressure before using ligation.

19. After a severe hemorrhage *always* put the patient to bed and elevate the damaged part (if it be an extremity or the head).

20. A clot which holds for twelve hours after a primary

hemorrhage will probably hold permanently; but even after twelve hours be watchful and insist on rest.

21. If recurrence of a hemorrhage from a limb is feared, mark with aniline or iodine the spot on the main artery where compression is to be applied, put on a tourniquet loosely, and order the nurse to screw it up and to send for the physician at the first sign of renewed bleeding. This must often be done in gunshot wounds.

22. In extra-dural hemorrhage, trephine. The side to be trephined is determined by the symptoms, and not by the situation of the injury. The opening is made on a level with the upper orbital border and one and a quarter inches behind the external angular process. This opening exposes the middle meningeal and its anterior branch (Keen). If this does not expose a clot, trephine over the posterior branch, on the same level and just below the parietal eminence. When the clot is found, enlarge the opening with the rongeur, scoop out the clot, and stop the bleeding by passing a catgut ligature through the dura, under the artery and out again, and then tying it.

23. In hemorrhage from a cerebral sinus, catch the edges of the opening with forceps if possible and ligate; apply a lateral ligature, or leave the forceps on for forty-eight hours, or compress firmly with *one* large piece of iodoform gauze.

24. In extra-medullary spinal hemorrhage rapidly advancing and threatening life, perform a laminectomy and arrest the hemorrhage.

25. In bleeding from a tooth-socket, use ice. If this treatment fails, plug with gauze infiltrated with tannin, close the jaws upon the plug, and hold them with Barton's bandage. If this expedient fails, soak the plug in Monsel's solution, and if this is futile, use the cautery. Pressure on the carotid and ice over the jaw and neck are indicated. It may be necessary to tie the common carotid.

26. In intra-abdominal hemorrhage, open the belly. If the blood accumulates so rapidly as to prevent the location of the bleeding point, compress the aorta or pack the abdominal cavity with large sponges. In parenchymatous hemorrhage, try packing with iodoform gauze. In the liver, if this fails, suture the torn edge or use the cautery. Severe wounds of the spleen demand splenectomy; those of the kidney, nephrectomy. Mesenteric vessels are ligated *en masse* with silk (Senn). Wounds of stomach and intestines causing hemorrhage require stitching of their edges. When there are an infinite number of points of bleeding, take a number of sponges, tie a piece of iodoform gauze firmly to each one, pack many places in the belly with the sponges, bring the gauze out of the wound, and remove the sponges from below upward one at a time, securing the bleeding points as they come into view.

27. In abdominal section for disease of the female pelvic organs, bleeding is limited by the clamp or by pressure-forceps. Ligation *en masse* is often practised. Use silk. A large mass can be transfixed and tied in sections. Bleeding edges are stitched. Areas of oozing are treated with temporary pressure and hot water, or, if this fails, by the cautery. Packing can be used as a tamponade, which is a gauze pouch, pieces of gauze being packed into this pouch after its insertion into the belly.

28. A ruptured varicose vein requires a compress, a bandage from the periphery up, and elevation.

29. For capillary hemorrhage use hot water and compression, or, if this fails, the cautery. Understand that capillary bleeding does not so much mean bleeding from genuine capillaries as it does bleeding from arterioles and venules.

30. Pressure above a wound stops arterial hemorrhage, but aggravates venous bleeding. Pressure below a wound stops venous hemorrhage, but increases arterial bleeding.

31. In severe epistaxis, or bleeding from the nose, pack the nares. Pass a Bellocq canula (Fig. 40) along the floor of one nostril into the pharynx, project the stem into the mouth, tie a plug of lint or gauze to the stem, and withdraw it. Carry out the same procedure upon the other nostril, pull the strings firmly forward, pack the nostrils from before backward, and tie the strings around the head. Soaking the lint or gauze in antipyrine solution is a good

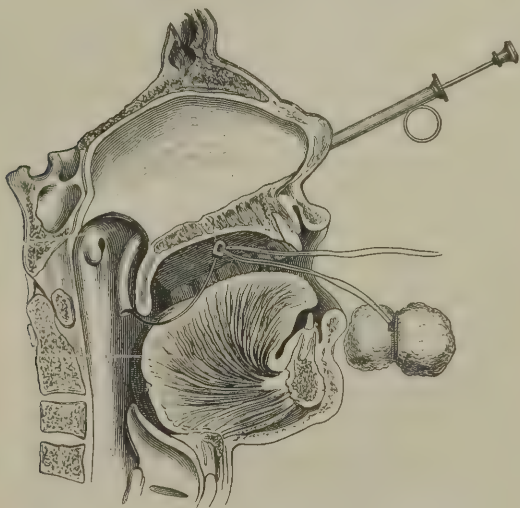


FIG. 40.—Plugging the Nares for Epistaxis (Guerin).

plan. Do not use subsulphate of iron, as it forms a disgusting, clotty, adherent mass. If a Bellocq canula is not obtainable, push a soft catheter into the pharynx, catch it with a finger, pull it forward, and tie the plug to it.

32. In gunshot wounds the primary hemorrhage is slight unless a large vessel is cut. The bleeding may be visible or may be internal (concealed), the blood running into a natural cavity or among the muscles. Capillary oozing is arrested

by very hot water and compression. Venous bleeding is usually arrested by compression. If a large vessel is the source of bleeding, enlarge the wound and tie the vessel. If the artery cannot be found in the wound, tie the main trunk.

33. In prolonged bleeding from a leech-bite, try compression over a plug saturated with alum or with tannin. If this fails, pass under the wound a hare-lip pin and encircle it with a piece of silk. If this fails, use the actual cautery.

34. In severe bleeding from the ear, elevate the head, put an ice-bag over the mastoid, give opium and acetate of lead, and, if blood runs into the mouth, plug the Eustachian tube with a piece of catheter.

35. Umbilical hemorrhage in infants requires pressure over a plug containing tannin or alum. If this fails, pass hare-lip pins under the navel and apply a twisted suture. If this fails, use the actual cautery.

36. Rectal bleeding requires elevation of the buttocks, insertion of plugs of ice, ice to the anus and perineum, astringent injections (alum), and the internal use of opium, ergot, and acetate of lead. If these means fail, plug the bowel over a catheter, or insert and inflate a Peterson bag or a colpeurynter, or tampon and use a T-bandge. If the bleeding persists or if a considerable vessel is bleeding, stretch the sphincter, catch the bowel and draw it down, seize the vessel, and tie it if possible; if not, leave the forceps in place. Failing in this, the actual cautery must be used.

37. Subcutaneous hemorrhage, if severe, demands that an incision be made and ligation be performed.

38. Bleeding from a cut urethral meatus requires the insertion of styptic cotton and the application of pressure. Moderate bleeding from the urethra can usually be arrested by a hot bougie, by hot injections, or by tying a condom over a catheter, and, after inserting it, inflating the condom

by blowing through the catheter and plugging the orifice of the instrument, thus using pressure. Sitting with the perineum on a thickly-folded towel is useful. Ice to the perineum does good. If these means are futile, perform an external urethrotomy and reach the bleeding point.

39. Hemorrhage from the prostate requires hot injections, the introduction of a large bougie first dipped in very warm water, and the retention of a catheter for two days. Perineal section may be required, or suprapubic cystotomy with packing which does not occlude the ureteral orifices.

40. Vesical hemorrhage usually ceases spontaneously, in which case the urine must be drawn off and the viscus be washed out frequently with a solution of boric acid to prevent septic cystitis. If blood-clots prevent the flow of urine, break them up with a catheter and inject vinegar and water. Perfect quiet is to be maintained, cold acid drinks to be given, ice-bags to be put to the perineum and hypogastric region, and opium with acetate of lead, ergot, or gallic acid to be given by the mouth. If the hemorrhage is severe or persistent, perform a suprapubic cystotomy.

41. In hemorrhage after lateral lithotomy, ligate if possible. If the vessel can be caught but cannot be ligated, leave the forceps in place. If we cannot catch the vessel with forceps, try a tenaculum. If the tenaculum fails, pass a threaded curved needle through the tissues around the vessel and tie the ligature. Plugs of ice and injections of hot water may be tried. These means failing, pressure is indicated. Take a canula, fasten to it a chemise (Fig. 41), empty clots from the bladder, insert the instrument into the viscus, and pack gauze between the sides of the canula and the chemise. The chemise is bulged out and pressure is made. Tie the canula by means of tapes to a T-bandage. Pressure is thus combined with vesical drainage. Buckstone

Brown makes pressure by inflating a rubber bag with air. The hot iron may occasionally be demanded.

42. Renal bleeding requires ice to the loin, tannic acid and opium, gallic acid and sulphuric acid, ergot, and perfect quiet. If the bleeding threatens life and the diseased organ is identified, perform a lumbar nephrectomy; if not sure which organ is diseased, perform an abdominal nephrectomy.

43. Vaginal hemorrhage requires the ligature or the tampon.

44. Severe uterine hemorrhage (unconnected with pregnancy) requires the tampon. Persistent hemorrhage due to morbid growths may require removal of the tubes and appendages, ligation of the uterine and ovarian arteries, or hysterectomy.

FIG. 41.—Canula à Chemise.

45. Hæmatemesis, or bleeding from the stomach, is treated by the swallowing of ice, giving tannic acid (dose, 20 or 30 grains) or Monsel's solution (3 drops). Never give tannic acid and Monsel's solution at the same time, as they mix and form ink. Opium is usually ordered. Acetate of lead and opium and gallic acid are favorite remedies, and ergot is used by many. Give no food.

46. In bleeding from the small bowel, give acetate of lead and opium, sulphuric acid, ergot, or Monsel's salt in pill form (3 grains), allow no food for a time, and insist on liquid diet for a considerable period.

47. In bleeding from the large bowel, use styptic injections (10 grains of alum or 5 grains of bluestone to ℥j of water). If bleeding is low down, use small amounts of the solution; if high up, large amounts. Do not use absorbable poisons.

48. Hæmoptysis, or bleeding from the lung, is treated by morphia hypodermatically, by perfect rest, by dry cups or ice over the affected spot if it can be located, by ergot, and by gallic acid. Gallic acid aids coagulation.[1]

Reactionary or Recurrent Hemorrhage (called also Consecutive, Intermediate, or Intercurrent).—This form of hemorrhage comes on during reaction from an accident or an operation—that is, during the first forty-eight hours. It is usually due to badly-applied ligatures, or may result from vascular excitement or from hypertrophied heart, the jumping arteries loosening the ligature. The Esmarch apparatus is not unusually the cause. The constricting band paralyzes the smaller arteries, which do not bleed during shock and do not contract as shock departs; hence bleeding comes on with reaction. To lessen the danger of the Esmarch apparatus, use a broad constricting band rather than a rubber tube. During reaction after an amputation, if slight hemorrhage occurs, elevate the stump and compress the flaps. If the hemorrhage persists or at any time becomes severe, make pressure on the main artery of the limb, open the flaps, turn out the clots, find the bleeding point, ligate, asepticize, close, and dress. In any severe reactionary hemorrhage, open the wound at once and ligate.

Secondary hemorrhage may occur at any time in the period between forty-eight hours after the accident or operation and the complete cicatrization of the wound. Secondary hemorrhage may be due to atheroma, to slipping of a ligature, to inclusion of nerve, fascia, or muscle in the ligature, to sloughing, to erysipelas, to septicæmia, to pyæmia, to gangrene, and to overaction of the heart. If during an

[1] The use of ergot is a general but questionable practice. Bartholow and others hold that this drug does harm; it contracts all the arterioles, and hence more blood flows from an area where there is damage. Purgatives do good in bleeding from the lung by taking blood to the abdomen and lowering blood-pressure.

operation the vessels are found atheromatous, acupressure had best be used, or pass a thread, by means of a Hagedorn needle, around the vessel, including a cushion of tissue in the loop of the ligature (this prevents cutting through). One great trouble with atheromatous arteries is that their coats cannot retract; another trouble is that the ligature cuts entirely through them. If after an operation the pulse is found to be forcible, rapid, and jerking, give aconite, opium, and low diet.

Treatment of Secondary Hemorrhage.—The method of treatment, supposing a case of leg-amputation in which, several days after the operation, a little oozing is detected, is to elevate the stump, apply two compresses over the flaps, and carry a firm bandage up the leg. If the bleeding is profuse or becomes so, make pressure on the main artery, open and tear the flaps apart with the fingers, find the bleeding vessel and tie it, turn out the clots, asepticize, close, and dress. If the bleeding begins at a period when the stump is nearly healed, cut down on the main artery just above the stump and ligate. In secondary hemorrhage from a blood-vessel in nodular tissue, throw a ligature around the vessel by a curved needle and tie higher up, or, if this fails, amputate. When secondary hemorrhage arises in a sloughing wound, apply a tourniquet or an Esmarch bandage, tear the wound open to the bottom with a grooved director, look for the orifice of the vessel, dissect the artery up and down until a healthy point is reached, and tie both ends. If this fails, include tissue in the ligature or use acupressure. In secondary hemorrhage from atheromatous vessels, use acupressure or include surrounding tissue in the ligature.

Secondary hemorrhage may occur after ligation in continuity, the blood usually coming from the distal side. If the dressings are slightly stained with blood, put on a graduated compress. If the bleeding continues or is severe, make

pressure on the main artery of the limb, open the wound and ligate, wrap the part in cotton, elevate, and surround with hot bottles. If this re-ligation is done on the femoral and fails, do not ligate higher up, as gangrene will certainly occur, but amputate at once, above the point of hemorrhage. If dealing with the brachial artery, do not amputate, but ligate higher up and make compression in the wound. In a secondary hemorrhage from the innominate, tie the vertebral. The best way to deal with secondary hemorrhage is not to have it, and thorough antisepsis is the greatest possible safeguard.

2. Operations on the Vascular System.

Paracentesis auriculi, or tapping the heart-cavity, has been suggested for the relief of an over-distended heart from pulmonary congestion. The right auricle should be tapped. Push the aspirator-needle directly backward at the right edge of the sternum, in the third interspace. This operation is not recommended, as it is highly dangerous and is of questionable value.

Paracentesis pericardii, or tapping the pericardial sac, is only done when life is endangered. Introduce the needle two inches to the left of the left edge of the sternum, in the fifth interspace, and push it directly backward (thus avoiding the internal mammary artery).

Operation for Varix of Leg.—In this operation, make, at several points in the course of the long saphenous vein, skin incisions each two inches long and in the long axis of the vessel. Clear the vessel at each incision, apply two ligatures an inch apart, and excise the vein between them. Never operate if the slightest phlebitis exists (Barker). Another method is as follows: The patient stands for a time before a fire to enlarge the veins. A hare-lip pin is pushed into the tissues an inch from the vein, at the upper end of its varicose portion; the pin is passed under the vein and emerges an

inch outside of it. A bit of catheter wrapped in gauze is laid over the vein, and a twisted suture is carried around the pin and over the pad. This operation is done lower down in one or two positions.

Open Operation for Varicocele.—The open operation is by far the best procedure for varicocele. The instruments used are a scalpel, an aneurysm-needle, a Reverdin needle, a grooved director, a dissecting-forceps, an Allis dry dissector, hæmostatic forceps, and scissors.

Operation.—The patient is recumbent and anæsthetized. The operator stands on the diseased side. The assistant stands on the sound side and makes pressure over the inguinal ring of the affected side. A fold of skin is pinched up on the scrotum, and the surgeon transfixes it in the line of the cord, so that he will have an incision about one and a half inches long running downward from below the external ring. The veins are reached by means of an Allis dissector and the cord is located and held aside. A double ligature of silk is passed under the veins by an aneurysm-needle. The threads are separated three-quarters of an inch, tied tightly, and cut. The veins between the ligatures are divided or excised. The scrotum is sewed up with silkworm gut, a small drainage-tube being used for twenty-four hours. Healing is complete in one week. Dr. Hearn, after resecting a portion of the vein-mass, ties the cut ends together and thus shortens the veins.

Subcutaneous Ligature for Varicocele.—In this operation, employ every antiseptic precaution. The patient stands, and the operator, sitting in front of him, holds the veins in a fold of skin away from the vas deferens by means of the thumb and index finger of the left hand. A large straight needle carrying a double piece of strong silk is passed entirely through the scrotum, between the veins and the vas. The needle is again inserted at the puncture from

which it emerged, is carried around under the skin and in front of the veins, and emerges at its original point of entry. The veins are thus surrounded by the silk. The patient, who now lies down, is placed under the first stage of ether, and the double ligatures are separated as far as possible from each other, tied, and cut off, the knots slipping in through the puncture. This operation presents certain dangers. The veins may be wounded and the vas or other structures may be included. In an operation it is always best to be able to see what we are doing; hence the open operation is preferred to the subcutaneous.

Phlebotomy, or Venesection.—The instruments used in venesection are a lancet or bistoury, a broom-handle, a fillet or tape, an antiseptic pad, and a bandage.

Operation.—The patient sits on a chair "with the arm abducted, extended, and inclined outward" (Barker). The surgeon stands to the right of the arm, holds the elbow with his left hand, and puts his thumb upon the vein below the intended point of puncture. Asepticize the parts and tie the tape above the elbow. The patient grasps the stick firmly and works his fingers to swell the veins. Either the median cephalic or median basilic can be punctured (Fig. 43). The median basilic is the more distinct, and is the vein usually selected. In puncturing it, do not go too deep, as nothing but the bicipital fascia separates it from the brachial artery. The median cephalic may be selected (we thus avoid endangering the brachial artery), but remember that under this vein lies the external cutaneous nerve (Fig. 42). Steady the

FIG. 42.—Superficial Veins in Front of the Elbow.

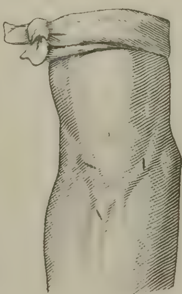


FIG. 43.—Incisions for Venesection.

(Bernard and Huette.)

vein with the thumb and open it by transfixion, making an oblique cut which divides two-thirds of it. Remove the thumb and allow bleeding to go on, instructing the patient to work his fingers. When faintness begins, remove the fillet, put an antiseptic pad over the puncture, apply a spiral reverse bandage of the hand and arm and a figure-of-8 bandage of the elbow, and place the arm in a sling for several days.

Transfusion of Blood.—This operation has been a recognized procedure since 1824, though it has certainly been known since 1492, when transfusion in the case of Pope Innocent VIII. was made. Its chief use is in severe hemorrhage, especially post-partum, in which it replaces the blood lost and supplies something for the heart to contract upon until new blood is formed. That it saves life is unquestionable, but the procedure falls short, in permanent result, of what was anticipated for it. The old view was that blood must come from the same animal, but Brown-Séquard demonstrated that the blood of various animals could be used, and Panum proved that defibrinated blood is as efficient as pure blood. This discovery of Panum indicates that the saline elements are those which are required; hence at the present day a saline fluid is more often transfused than blood. This fluid is generally thrown into the cellular tissue rather than into the veins. In saline injection by hypodermoclysis, which is so useful in collapse, from ten to sixteen ounces of warm normal salt-solution are gradually passed into the cellular tissue by means of a fountain-syringe and a large aspirating-needle, the region of injection being rubbed and kneaded. Some physicians inject a solution consisting of boiled water and phosphate of soda.

Transfusion of blood may be *mediate*. A thoroughly healthy man is bled from the median basilic vein, the blood being caught in an aseptic tumbler which stands in a basin of water at 100° F. The heat prevents coagulation of the

blood, which is defibrinated by whipping with a clean fork. The median basilic vein of the sufferer is exposed by an incision, and is lifted up from its bed by a probe and opened. There are sucked up in an aseptic syringe two ounces of blood, which is at once injected into the vein of the patient; two ounces more are allowed to run from the donor and are defibrinated, and two ounces more are thrown into the veins of the recipient, in the interval pressure being used to prevent bleeding. There are thus introduced ten, twelve, or sixteen ounces. The chief dangers are embolism, sepsis, and the entrance of air.

Transfusion of blood may be *immediate*. Expose with antiseptic care a vein of the donor at the bend of the elbow

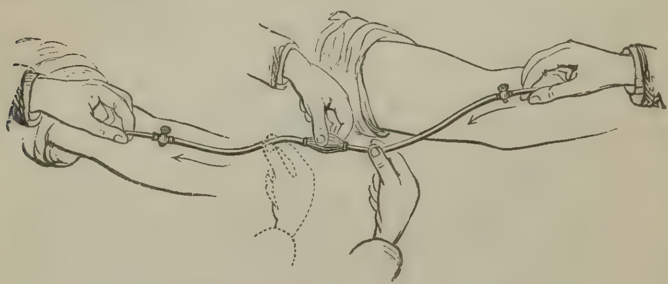
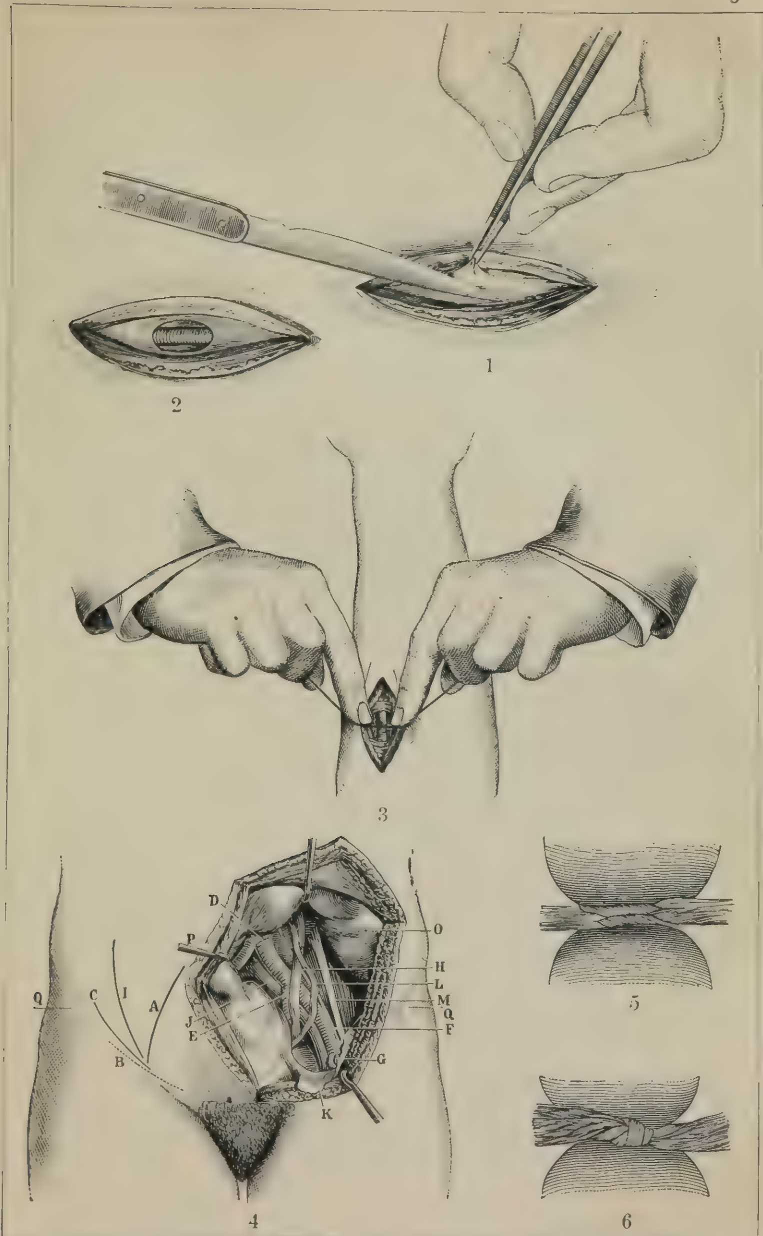


Fig. 44.—Aveling's Apparatus for Immediate Transfusion.

and a vein of the recipient in the same situation, fillets being tied above each elbow. The veins must be thoroughly bared to the extent of three-quarters of an inch. Open the veins and introduce the canulæ of an Aveling syringe (Fig. 44), which instrument is filled with normal salt-solution. The opening is small and transverse. The canula in the vein of the donor is pushed toward the hand, that in the vein of the recipient being pushed toward the shoulder, the arms of giver and receiver resting upon a table. Remove the fillets. Compress the tube between the bulb and the giver, open the clips, squeeze the bulb to drive the salt-solution into the



1. Opening the Sheath for Ligation of an Artery (Guerin). 2. Sheath of Artery Open (Guerin). 3. Tightening the Knot in Ligation (Guerin). 4. Anatomy of the Iliac Arteries, and showing the lines of incision for their ligation: 1, Abernethy's incision (Guerin). 5, 6. Ballance and Edmund's Stay-knots.

giver, remove the pressure from the tube between the bulb and the donor, compress the tube between the bulb and the recipient, and allow the bulb to expand and fill with blood; force this blood out by the same plan, and thus continue until six, eight, or ten ounces are transferred. Dress each patient as after phlebotomy. Saline transfusion is sometimes performed.

Arterial Transfusion.—Hueter prefers the arterial method of transfusion, in order to send the blood more gradually to the heart, and thus prevent sudden disturbance of the circulation. A little air in an artery will do no harm, and the danger of venous embolism is avoided. The radial artery is exposed and surrounded by three ligatures, and the thread toward the heart is at once tied. The distal ligature is slightly tightened to cut off anastomotic blood-supply. The artery is cut transversely half through; the syringe is inserted, pointed toward the periphery, and fastened by the third ligature; the second ligature is loosened and the blood is injected. On finishing, the peripheral thread is tied tightly and that portion of the artery which held the canula is excised.

3. Ligation of Arteries in Continuity.

The *instruments* used in this operation are two scalpels (one small, one medium), two dissecting-forceps, several hæmostatic forceps, toothed forceps, blunt hooks or broad metal retractors, an Allis dissector, an aneurysm-needle, for superficial arteries the instrument of Saviard, for deep vessels the needle of Dupuytren, ligatures of catgut, of chromicized gut, or of silk, and the reflector or electric forehead-lamp for deep vessels.

The *position* varies according to the vessel, though the body is supine except when ligation is to be performed on the gluteal, sciatic, or popliteal. The operator, as a rule, stands upon the affected side, cutting from above downward on the right side and from below upward on the left side.

Operation.—Accurately determine the *line* of the artery, and make an incision at an angle of five degrees to this line, avoiding subcutaneous veins, and holding the scalpel like a fiddle-bow or a dinner-knife while cutting the superficial parts, and like a pen while incising the deeper parts. On reaching the deep fascia, make out the required muscular gap by the eye and finger, so moving the extremity as to bring individual muscles into action. Treves cautions us not to depend upon the yellow line of fat, which often cannot be seen in emaciated people or when an Esmarch bandage is employed; nor upon the white line due to attachment to the fascia of an intermuscular septum. In opening the deep portion of the wound, relax the bounding muscles by altering the posture. Open a muscular interspace with the knife or the Allis dissector. Make the depths of the wound as long as the superficial incision. Do not tear structures apart with a grooved director (Treves). Arrest hemorrhage as it occurs. Try to find the situation of the artery with the finger. Pulsation is present, but it may be very feeble and hard to detect. The artery feels like a very thin rubber tube; it is compressible, though not so easily as a vein, and when compressed feels like a flat band which is thinner in the centre than at the edges (Treves). A nerve feels like a hard round cord. The veins are soft, larger than their related arteries, and so very compressible that they can scarcely be felt when pressed upon, compression causing distal distention. If the wound can be seen well into, it will be noted, as Treves asserts, that "the nerves stand out as clear, rounded, white cords; that the veins are of a purple color and of somewhat uneven and wavy contour; that the artery is regular in outline and of a pale-pink or pinkish-yellow tint, the large vessels being of lighter color than the small." All the arteries of the upper extremity and all the arteries below the knee are accompanied by two veins known

as "venæ comites." The arteries of the head and neck have each a single attending vein, except the lingual, which has venæ comites. Most of the smaller arteries of the trunk (pudic, internal mammary, etc.) have venæ comites. These companion veins may lie on each side of the artery or in front and back of it, and they communicate with one another by transverse branches crossing the artery. On reaching the sheath, pick up this structure with toothed forceps so as to make a transverse fold, and thus avoid catching the artery or vein; lift the fold to see that it is free, and open the sheath by cutting toward the edge of the forceps with a scalpel held obliquely with its back toward the vessel, thus making a small longitudinal incision (Pl. 3, Figs. 1, 2). Hold the edge of the incised sheath with the forceps; pass an aneurysm-needle under the vessel and from the forceps; this clears one-half of the vessel. Grasp the other edge of the sheath and pass the aneurysm-needle all the way around the vessel, threading the needle when it emerges and withdrawing it. In passing the needle this last time, carry it away from its most dangerous neighbor. If venæ comites are in the way, try and separate them, but if this proves difficult, include them in the ligature. In small vessels always include them if they are in the way, as this saves trouble. If, in passing the needle, a large vein is severely wounded (such as the femoral), Jacobson advises the employment of digital pressure in the lower portion of the wound while the artery is being tied on a level above or below that of the vein-injury, and after ligation the maintenance of pressure on the wound for a couple of days. A slight puncture in a vein merely requires a lateral ligature. After getting a ligature under an artery, press for a moment upon the artery over the ligature, which is held taut;


FIG. 45.—Reef-knot.

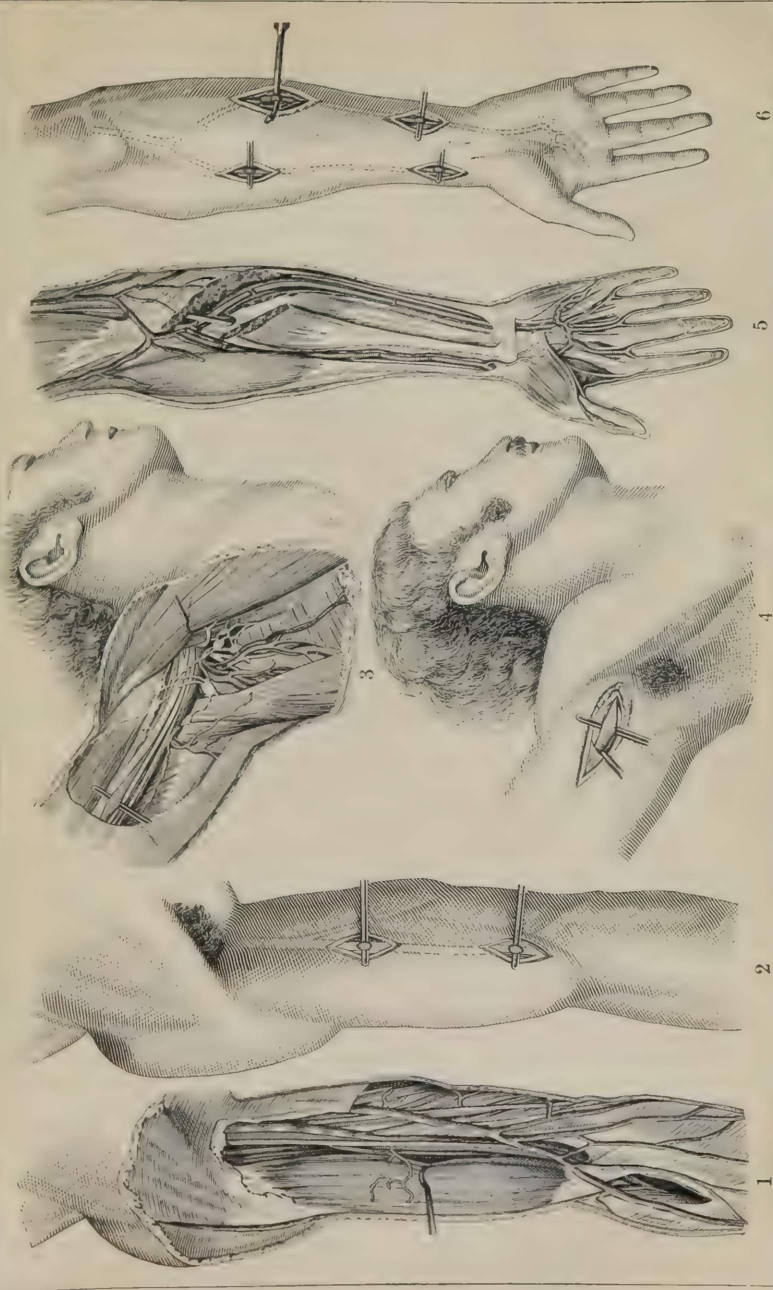
this pressure will show that pulsation below is arrested. Tie the thread at right angles to the vessel with a reef-knot (Fig. 45), rupturing the internal and middle coats. As the ligature is tightened place the extended index fingers along the ligature up to the artery (Pl. 3, Fig. 3), using the middle joints as the fulcrum of a lever by placing them against each other.

Ballance and Edmunds have recently claimed, as Scarpa and Sir Philip Crampton did long since, that it is not necessary to divide the internal and middle coats to ensure obliteration. If this claim be true, the danger of secondary hemorrhage can be greatly lessened. Holmes, however, thinks the older method the more certain of the two. Ballance and Edmunds recommend that the artery be surrounded with a doubled ligature of floss-silk, that each ligature be tied with one turn of a reef-knot, and that the final turn be made by gathering together as single pieces both ends of each ligature and tying them to each other. This knot is known as the "stay-knot" (Pl. 3, Figs. 5, 6).

The chief dangers after ligation are secondary hemorrhage and gangrene. Rigid asepsis usually prevents the first; rest, elevation, and heat antagonize the second.

Radial Artery.—The *line* of the radial artery is from the middle of the front of the elbow-joint to the front of the styloid process of the radius. The *line* in the tabatière is from the apex of the styloid process to the posterior angle of the first interosseous space.

Anatomy (Pl. 4, Fig. 5).—The radial artery, though smaller than the ulnar, is the direct continuation of the brachial. It arises from the bifurcation of the brachial, half an inch below the bend of the elbow, runs down the radial side of the forearm to the front of the styloid process of the radius, passes beneath the extensor muscles of the first metacarpal bone and of the first phalanx of the thumb, and over the carpus to the first interosseous space, where it is crossed by the



1, Anatomy, 2, Ligation, of the Brachial Artery. 3, Anatomy of the Axilla. 4, Ligation of the Third Part of the Axillary Artery. 5, Anatomy, 6, Ligation, of the Radial and Ulnar Arteries. (From Bernard.)

extensor secundi internodii pollicis, and enters into the palm between the heads of the first dorsal interosseous muscle to form the deep palmar arch. The artery in the upper part of its course is somewhat overlaid by the supinator longus muscle; throughout the rest of the forearm it is superficial. In the upper third of the forearm it lies between the supinator longus on the outside and the pronator radii teres on the inside; in the lower two-thirds of the forearm it lies between the supinator longus on the outside and the flexor carpi radialis on the inside. The radial nerve is to the outer or radial side of the artery, well removed from the artery in the upper third, nearer to the artery in the middle third, far external to the artery in the lower third, the nerve at this point passing beneath the supinator longus muscle. The radial artery, from above downward, rests upon the biceps tendon, the short supinator muscle, the pronator radii teres muscle, the flexor sublimis, the flexor longus pollicis, the pronator quadratus muscles, and the radius. It has two venæ comites. The best guide to the radial artery in the forearm is the outer edge of the flexor carpi radialis muscle or the inner edge of the supinator longus muscle.

The tabatière, or snuff-box, is an anatomical triangle whose base is the lower edge of the posterior annular ligament, one side being formed by the extensor secundi internodii pollicis tendon, the other by the extensor ossis metacarpi and the extensor primi internodii pollicis tendons; the floor consists of the trapezium, scaphoid, and base of the first metacarpal bone.

Operations: Ligation in the tabatière is a dissecting-room operation of but little practical use.

Ligation in the Lower Third.—In this operation (Pl. 4, Fig. 6) the forearm is supinated and held by an assistant. The surgeon stands on the side operated upon, and cuts from above downward on the right arm and from below

upward on the left arm. The line of the vessel is laid down and marked with iodine or aniline. An incision one and a half inches long is made at an angle of five degrees to this line and midway between the supinator longus and the flexor carpi radialis muscles, which incision must not extend below the level of the tuberosity of the scaphoid bone. In the superficial fascia watch for the superficial radial vein, and if it comes into view, push it aside. Incise the superficial fascia and locate each guide-tendon. Open the deep fascia in the length of the first cut; try and separate the veins, but if they strongly adhere, include them in the ligature. There is no special fascial sheath. The radial nerve will not be seen, but a division of the anterior cutaneous is frequently found in relation with the vessel. The needle can be passed in either direction. A high origin of the superficialis volæ artery is confusing.

Ligation in the Middle Third.—In this operation the position is the same as in the preceding. A two-inch incision is made. Veins of the subcutaneous tissues are avoided. Lying upon the deep fascia is the anterior division of the musculo-cutaneous nerve. Open the fascia; find the inner edge of the supinator longus muscle and draw it outward, flexing the elbow if necessary. Be sure not to get external to this muscle. Find the vessel where it is bound down by connective tissue to the pronator radii teres muscle, separate the veins, and pass the ligature from without in. The nerve is external.

Ligation in the Upper Third.—In this operation the incision is like the last, only higher up. The artery is between the supinator longus and the pronator radii teres, which muscles are at once differentiated by the different direction of their fibres. The artery is usually covered by the supinator longus muscle, which must be retracted externally. The nerve is not seen. The ligature is passed in either direction.

Ulnar Artery.—No one *line* will overlie the entire ulnar artery. The line of the upper third runs from the middle of the front of the elbow-joint to the point of junction of the upper and middle thirds of the ulna. The line of the lower two-thirds runs from the tip of the internal condyle of the humerus to the radial side of the pisiform bone (Pl. 4, Figs. 5, 6).

Anatomy.—(Pl. 4, Fig. 5.) The ulnar artery arises from the brachial bifurcation and runs obliquely inward under the median nerve and a group of muscles from the internal condyle; it turns down the arm, being covered in the middle third of its course by the flexor carpi ulnaris muscle. In the lower third it is superficial, between the tendons of the flexor carpi ulnaris on the inside and the flexor sublimis digitorum on the outside, the vessel being a little overlapped by the flexor carpi ulnaris. This vessel rests first upon the brachialis anticus muscle, next upon the flexor profundus, to which it is bound by a distinct process of fascia, and next upon the annular ligament, which structure it crosses to become the superficial palmar arch. Two venæ comites attend the vessel. In the upper third the nerve is well internal, but in the lower two-thirds the nerve lies near the artery and to its ulnar side. The guide is the outer edge of the flexor carpi ulnaris.

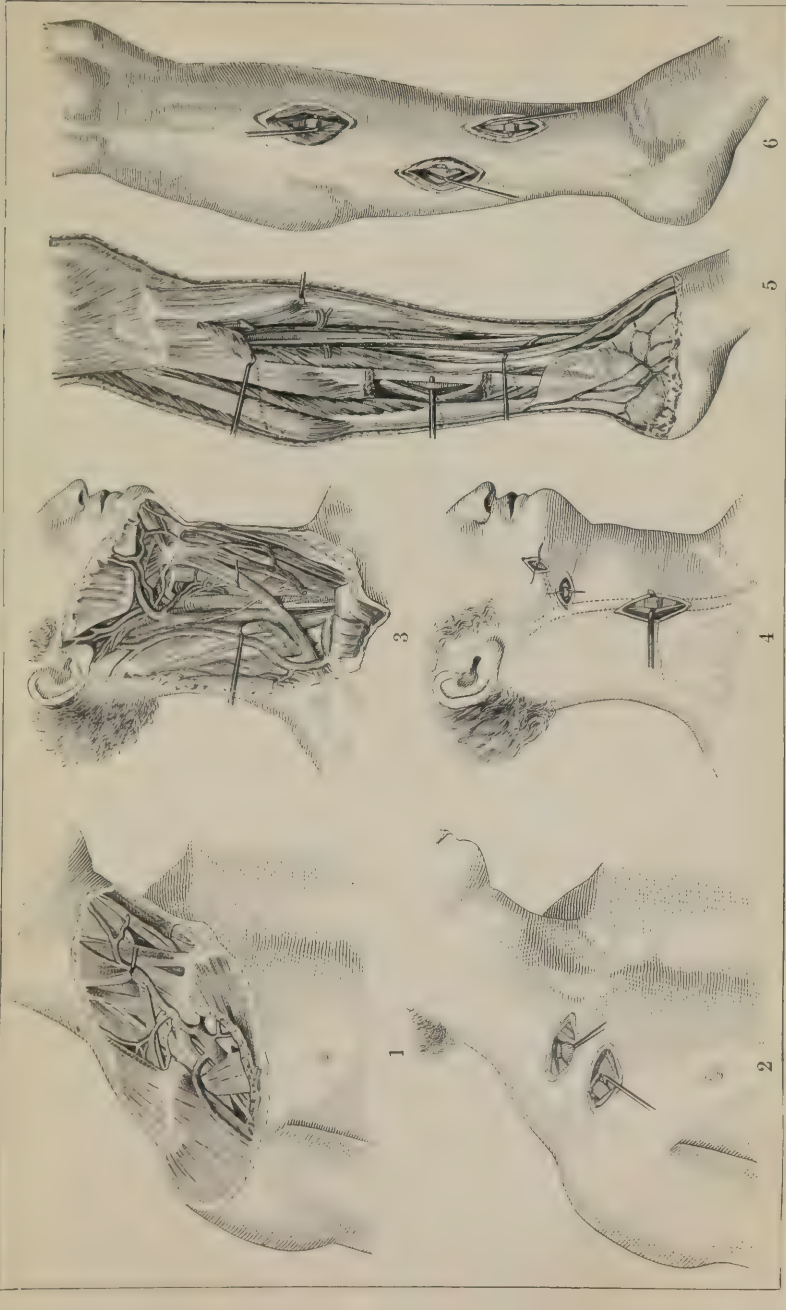
Operations (Pl. 4, Fig. 6): *Ligation in the Lower Third.*—The position in this operation is the same as for the radial artery. Make a two-inch incision to the radial side of the tendon of the flexor carpi ulnaris, which incision is not taken lower than a point one inch above the pisiform bone. Avoid the superficial ulnar vein in the subcutaneous tissue. Open the deep fascia, find the tendon of the flexor carpi ulnaris, flex the wrist and draw the tendon inward, open the sheath of fascia, separate veins if possible, and pass the ligature from within outward to avoid the nerve. On the artery is the palmar

cutaneous branch of the ulnar nerve, and this branch must not be included in the ligature.

Ligation in the Middle Third.—In this operation the position is the same as in the preceding one, the incision being three inches long. Avoid the anterior ulnar vein and the branches of the internal cutaneous nerve in the superficial fascia. Open the deep fascia a little external to the superficial cut (Treves). Find the space between the flexor carpi ulnaris and the superficial flexor, feeling with the index finger, and when the space is discovered, flex the wrist, retract the flexor carpi ulnaris inward and the flexor sublimis digitorum outward, open the fascia, find the ulnar nerve, look external to it for the artery, clear the vessel, separate the venæ comites, and pass the needle from within outward.

Brachial Artery.—The *line* of the brachial artery is from the junction of the anterior and middle thirds of the outlet of the axilla, the arm being abducted and the forearm supinated, to the middle of the front of the elbow-joint.

Anatomy (Pl. 4, Fig. 1).—The brachial artery is the prolongation of the axillary, and extends from the lower edge of the teres major muscle to half an inch below the bend of the elbow, where it divides into the radial and ulnar. It lies first to the inner side of the arm, but passes to the front of the elbow. It is crossed by no muscle, and is in fact superficial, barring its being somewhat overlaid in part of its course by the edge of the biceps muscle. The median nerve is outside above, crosses over or under it about the middle of the arm, and reaches the inside. The coraco-brachialis and biceps muscles are external, and both often overlap the vessel. The ulnar nerve is internal above, and the median nerve below, the middle. The basilic vein is internal to the artery, being outside the deep fascia to the upper third, at which point it pierces it. The artery above is separated from the long head of the triceps by the musculo-spiral nerve and superior profunda



1, Anatomy, 2, Ligation, of the Subclavian Artery and First Part of the Axillary Artery. 3, Anatomy of the Neck. 4, Ligation of the Carotid, Lingual, and Facial Arteries. 5, Anatomy, 6, Ligation, of the Anterior Tibial and Peroneal Arteries. (From Bernard.)

artery and vein; it rests from above down on the inner head of the triceps, the coraco-brachialis, and the brachialis anticus. The artery is covered by skin and by superficial and deep fascia. The internal cutaneous nerve lies in front of the artery, upon the deep fascia, until it pierces the fascia along with the basilic vein. The artery has venæ comites, and in its upper third has also the basilic vein to its inner side. The guide to the brachial is the inner edge of the biceps. Just in front of the elbow-joint the artery lies in a triangle the base of which is formed by an imaginary transverse line above the condyles, the apex by the junction of the pronator radii teres and the supinator longus. The outer line is the supinator longus, the inner is the pronator radii teres, and the floor is formed by the brachialis anticus and the supinator brevis. From within outward the triangle contains the median nerve, brachial artery, tendon of the biceps, anastomosis of the superior profunda and radial recurrent arteries, and the musculo-spiral nerve.

Operations: Ligation at the Bend of the Elbow.—In this operation (Pl. 4, Fig. 2) extend the arm moderately and abduct, and allow it to lie upon its posterior aspect. The forearm is supinated. The surgeon stands upon the side operated upon, and cuts from above downward on the right side and from below upward on the left side. Accurately locate the tendon of the biceps and the median basilic vein. An incision is made parallel with the inner edge of the biceps tendon and two inches in length, the centre of this cut being in the crease of the elbow. On exposing the median basilic vein, retract it inward, open the bicipital fascia, clear the artery of fat, separate the venæ comites, and pass the ligature from within outward to avoid the median nerve. The above operation is not frequently performed.

Ligation in the Middle of the Arm.—In this operation ex-

tension and abduction of the arm and supination of the fore-arm are made. An assistant holds the forearm, but the arm should not rest upon the table, because, if it be allowed to do so, the inner head of the triceps will be forced forward and may overlie the artery, and thus complicate the operation. Locate the inner edge of the biceps, which is the guide. Make an incision three inches long in the line of the artery. Incise the skin and fascia, flex the elbow slightly, retract the biceps outward, feel for the artery, open its sheath, separate its venæ comites, and, having located the median nerve, pass the ligature from it. In the middle of the arm the nerve is in front of or behind the vessel, above the middle it is external, and below the middle internal. High up the arm the inner edge of the coraco-brachialis is the guide, rather than the biceps, and at this point the basilic vein perforates the deep fascia and runs along to the inner side of the artery; hence, high up, the artery has three companion veins, and there is seen the ulnar nerve to the inside of the artery.

Axillary Artery.—To determine the *line* of the axillary artery, place the arm at right angles to the body and lay down a line from the middle of the clavicle to the humerus near the inner border of the coraco-brachialis. The line of the third portion can easily be approximated by projecting the line of the brachial upward.

Anatomy (Pl. 4, Fig. 3; Pl. 5, Fig. 1).—The axillary artery is the continuation of the subclavian, and runs from the lower margin of the first rib to the inferior border of the teres major muscle. It is divided into three portions by the pectoralis minor muscle. The first portion is above, the second portion is behind, and the third portion is below, the pectoralis minor. The position of the artery varies with the position of the limb. When the arm is parallel with the body the artery is far from the surface and forms a curve

whose convexity is upward and outward. When the arm is at right angles to the body the vessel is nearer the surface and straight. When the arm is raised above a right angle the artery comes near the surface and forms a curve with the convexity downward.

The first portion of the axillary artery is occasionally ligated. It lies upon the first intercostal muscle and the first serration of the great serratus muscle, and has behind it the posterior thoracic nerve; on the outer side of the artery is the brachial plexus; on its inner side is the axillary vein; in front of it are the clavicle, the great pectoral muscle, the subclavius muscle, the costo-coracoid membrane, the cephalic and acromio-thoracic veins, and the external anterior thoracic nerve. The branches of the first part of the axillary artery are the superior thoracic and the acromio-thoracic. The brachial plexus is external and posterior. The second part of the artery is not ligated. The third part is covered in front, above, by the great pectoral, but is covered below by skin and fascia; behind, it has the tendon of the subscapularis, the latissimus dorsi, and the teres major; the coraco-brachialis is on the outer side; the axillary vein is on the inner side. It is important to remember that there may be three veins, one external and two internal. The axillary vein is formed by the venæ comites of the brachial artery joining, and this new vein effecting a junction with the basilic vein. The median nerve lies upon the axillary artery in the upper part of the third portion of the vessel's course, and passes to the outer side. The musculo-cutaneous nerve is external, but it is only seen high up; the ulnar nerve is internal; the lesser internal and the internal cutaneous nerves are internal; the musculo-spiral and the circumflex nerves are behind. The branches of the third portion of the axillary artery are the subscapular and the anterior and posterior circumflex.

Operations: Ligation of the Third Portion (Pl. 4, Fig. 4).—The position in this operation is supine with the shoulders raised and the arm abducted to a right angle. The surgeon stands between the patient's arm and side. An incision is made three inches in length. It begins at the junction of the anterior and middle thirds of the outlet of the axilla and curves downward along the inner margin of the coraco-brachialis muscle, which is the guide. Incise the integuments and fascia, find the coraco-brachialis muscle, and draw it outward. The vein or veins will be prominent and may overlie the vessel. Feel for the pulsations of the artery, find the median nerve and draw it outward, draw the internal cutaneous nerve inward, clear the artery from the venæ comites, and pass the ligature from within outward. Apply the ligature well below the circumflex branches.

Ligation of the First Part.—This operation (Pl. 5, Fig. 2) was first performed in 1815 by Chamberlaine of Jamaica. The position is supine, the upper part of the body being raised, a sand-pillow being placed between the scapulæ to ensure carrying back of the point of the shoulder, and the arm being brought down along the side. In operating on the left side the surgeon stands on the outer side of the left arm; in operating on the right side he stands to the right of the subject's head and leans over his shoulder. The incision, which is slightly curved downward, begins external to the sterno-clavicular joint and ends external to the coracoid process. The incision is half an inch below the clavicle. Incise skin, platysma myoides muscle, superficial nerves, and deep fascia. In the outer angle of the wound watch out for the acromio-thoracic artery and the cephalic vein. Incise the pectoralis major; find the pectoralis minor and draw it down; open the costo-coracoid membrane by a vertical incision near the coracoid process. The cephalic vein points out the situation of the axillary vein. Find the brachial

plexus, feel for the artery internal to it, clear the vessel, draw the vein internally, and pass the needle from within outward. This avoids the dangerous neighbor, which is the axillary vein. This operation is difficult, dangerous, and unusual, and in its performance the axillary vein, which has a close attachment to the costo-coracoid membrane, is apt to be torn.

Subclavian Artery.—There is no *line* for this vessel.

Anatomy (Pl. 5, Fig. 1).—The subclavian artery of the right side arises from the innominate; of the left side, from the arch of the aorta. The subclavian is divided into three parts. The first part runs from the origin of the vessel to the inner border of the scalenus anticus muscle; the second part lies behind the scalenus anticus muscle; and the third part runs from the outer edge of the muscle to the lower border of the first rib.

At the present day the first and second portions are not ligated. The third portion is contained in the subclavian triangle (Fig. 46), and is superficial. It rises, as a rule, to half an inch above the clavicle. The subclavian vein is below the artery, being separated from it by the scalenus anticus muscle. The brachial plexus is above and external to the artery. The vessel rests upon the first rib, and behind it is the scalenus medius muscle. The suprascapular and transversalis colli arteries and veins and branches of the cervical plexus lie in front of the artery, and the external jugular vein crosses it at its inner side. The third portion gives off no branches.

Ligation of the Third Part.—This operation (Pl. 5, Fig. 2) was first successfully performed in 1817 by Post of New York. The *position* is as follows: place the patient upon his back, raise the shoulders, extend and turn the head toward the opposite side, pull down the arm, and hold it by pushing the forearm under the patient's back (Treves).

This pulls down the clavicle, thus increasing the size of the subclavian triangle. The operator stands facing the shoulder, with his back toward the patient's feet. Draw the skin over the subclavian triangle, half an inch above the clavicle, down upon this bone, and incise. This manœuvre avoids the external jugular vein and gives an incision half an inch above the collar-bone. The incision reaches from the anterior edge of the trapezius to the posterior border of the sterno-cleido mastoid (Fig. 46), and is about three inches long. By this incision are divided the skin, the superficial fascia, the platysma myoides, the vein running from the cephalic to the external jugular, and some superficial nerves. Open the deep fascia. Draw the external jugular vein into the outer angle of the wound, and do not divide it unnecessarily; if forced to do so, tie the vein with two ligatures and cut between them. Find the outer edge of the anterior scalene muscle, and run the finger down along it to the tubercle on the first rib. Draw up the posterior belly of the omo-hyoid muscle. With the finger on the tubercle recall the fact that the vein is in front of the finger and the artery is behind it, and that the subclavian vein is on a lower plane than the artery. The artery is felt beating as it lies upon the rib. Clear the artery and expose the lower cord of the brachial plexus. Guard the vein with the finger and pass the needle from above downward, as the plexus, which is in more danger than the vein, is to be avoided. In this operation never cut the transversalis colli or suprascapular arteries, as they are necessary to the future anastomotic circulation. If the field of operation is too small, incise the trapezius or sterno-cleido-mastoid or both.

Region of the Neck.—*Anatomy.*—The side of the neck is that space between the median line in front and the anterior edge of the trapezius behind, which space is limited below by the clavicle and above by the body of the jaw and an

imaginary line running from the angle of the jaw to the mastoid process. The sterno-cleido-mastoid muscle divides this space into an anterior and a posterior triangle, and each of the triangles is subdivided by other structures, the anterior into three spaces and the posterior into two (Fig. 46).

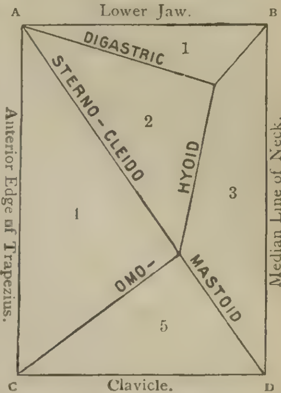


Fig. 46.—The Triangles of the Neck, right-sided view (after Keen): 1. Submaxillary triangle; 2. triangle of election, or superior carotid triangle; 3. Triangle of necessity, or inferior carotid triangle; 4. Occipital triangle; 5. Subclavian triangle.

Anterior Triangle.—The anterior triangle is bounded in front by the median line of the neck, behind by the anterior margin of the sterno-cleido-mastoid, and above by the body of the lower jaw and an imaginary line from the angle of the jaw to the mastoid process. This space is subdivided into three smaller triangles, namely, the inferior carotid, the superior carotid, and the submaxillary.

The inferior carotid triangle is called the "triangle of necessity," because the common carotid in it is ligated, not from choice, but through force of necessity. It is bounded in front by the median line, above by the anterior belly of the omo-hyoid, and below by the anterior edge of the sterno-mastoid. The floor of this triangle is composed of the longus colli, the scalenus anticus, and the rectus capitis anticus major muscles.

The superior carotid triangle is known as the "triangle of election," because, whenever possible, it is elected to tie the carotid in this situation. In this region the carotid is superficial, and there can be tied either the external, the internal, or the common carotid, as may be desired. The triangle is bounded behind by the anterior edge of the sterno-mastoid, above by the posterior belly of the digastric, and below by

the anterior belly of the omo-hyoid. Its floor is composed of the inferior and middle constrictors of the pharynx and the thyro-hyoid and hyoglossus muscles.

The submaxillary triangle is bounded above by the body of the jaw and an imaginary line from the angle of the jaw to the mastoid process, behind by the posterior belly of the digastric and the stylo-hyoid muscle, and in front by the middle line of the neck. Its floor is composed of the digastric, mylo-hyoid, and hyoglossus muscles.

The posterior triangle is bounded in front by the posterior border of the sterno-mastoid, behind by the anterior edge of the trapezius, and below by the clavicle. The posterior belly of the omo-hyoid subdivides it into two smaller spaces, the occipital and subclavian triangles.

The subclavian triangle is bounded above by the posterior belly of the omo-hyoid, below by the clavicle, and in front by the posterior border of the sterno-mastoid. Its floor is formed by the first rib and the first serration of the serratus magnus muscle.

The occipital triangle is bounded in front by the posterior edge of the sterno-mastoid, behind by the anterior border of the trapezius, and below by the posterior belly of the omo-hyoid muscle.

Common Carotid Artery.—The *line* of the common carotid artery is from the sterno-clavicular articulation to midway between the angle of the jaw and the mastoid process, the head being turned toward the opposite side.

Anatomy (Pl. 5, Figs. 1, 3).—The right common carotid arises from the innominate opposite the sterno-clavicular joint; the left common carotid arises from the arch of the aorta. In the neck the two carotids possess identical relations. The common carotid runs upward and outward from behind the sterno-clavicular articulation to a level with the upper border of the thyroid cartilage, at which

point it divides into the external and internal carotids. The common carotid is contained in a sheath from the cervical fascia, which sheath also holds, though in separate compartments, the internal jugular vein on the outer side of the artery and the pneumogastric nerve between the vein and artery and behind them. The anterior edge of the sterno-mastoid muscle lies over the artery and is a guide. Low in the neck the common carotid is deep, being covered by skin, superficial fascia, platysma, deep fascia, and the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles. Above the omo-hyoid the vessel is more superficial, being covered by the skin, superficial fascia, platysma, deep fascia, and the anterior edge of the sterno-mastoid. Upon the sheath (occasionally within it), above the crossing of the omo-hyoid muscle, lies the descendens noni nerve—the descending branch of the ninth pair of Willis (the hypoglossal). This nerve is a valuable guide to the sheath in the triangle of election.

The sterno-mastoid branch of the superior thyroid artery crosses the carotid a little below its bifurcation, and the superior thyroid veins cross it in this region; the middle thyroid vein crosses the middle of the line of the artery, and the anterior jugular vein crosses low down. The carotid rests upon the longus colli and rectus capitis anticus major muscles, the sympathetic nerve lying between the last-named muscle and the vessel, outside the carotid sheath. The recurrent laryngeal nerve passes behind the carotid below the omo-hyoid muscle, and the inferior thyroid artery passes behind the carotid just above the omo-hyoid muscle. The carotid is in relation internally with the trachea, thyroid gland, larynx, and pharynx. On its outer side are the pneumogastric nerve (which is on a posterior plane) and the jugular vein. On the left-hand side, low down in the neck, the jugular vein often lies in front, or partly in front,

of the artery. Ligation of the common carotid was first successfully performed in 1806 by Sir Astley Cooper.

Ligation in the Triangle of Necessity.—In this operation the *position* is supine with the shoulders raised, a sand-pillow under the neck, and the head turned to the opposite side with the chin raised. The operator stands upon the side operated upon. The incision, three inches long, at an angle of five degrees to the arterial line, runs from the level of the cricoid cartilage downward and inward toward the sterno-clavicular joint, following the inner border of the sterno-cleido-mastoid. Avoid cutting the external jugular vein, the course of which should be outlined before making the incision. Open the deep fascia, draw the sterno-cleido-mastoid outward, retract the sterno-hyoid and sterno-thyroid muscles inward, and feel for the carotid tubercle of Chassaignac. This tubercle is the costal process of the sixth cervical vertebra, and lies directly under the artery. The tubercle is found about the point at which the omo-hyoid crosses the carotid. When the tubercle is found we know the situation of the artery, and that the triangle of necessity is below, and the triangle of election above, the finger. Pull the omo-hyoid muscle upward. Open the sheath on its inner side, clear it, and pass the needle from without inward to avoid the internal jugular vein, remembering that the pneumogastric nerve is in the same sheath as the artery and vein, posterior and external to the artery. In this operation the inferior thyroid veins are much in the way, the anterior jugular vein crosses low down, and on the left side, at the root of the neck, the internal jugular vein may be in front of the carotid artery. If the incision is not sufficiently wide, incise the sterno-cleido-mastoid or the sterno-hyoid and thyroid. In the triangle of necessity the descendens noni nerve does not serve as a guide to the sheath.

Ligation in the Triangle of Election.—In this operation

the *position* is the same as in the preceding one. An incision, three inches in length, is made along the anterior edge of the sterno-mastoid in the line of the artery, the middle of this incision being opposite the cricoid cartilage. In cutting the superficial fascia, avoid the external jugular vein. Open the deep fascia, retract the sterno-cleido-mastoid outward, feel for the carotid tubercle, draw the omo-hyoid downward, find the descendens noni nerve upon the sheath, open the sheath at its inner side, and pass the needle from without inward. This incision permits ligation of either the superior thyroid or the external, internal, or common carotid, and if it be extended up a little there can be tied through it the lingual, and even the facial and occipital, arteries.

External Carotid Artery.—The *line* of the external carotid artery is the upper portion of the common carotid line.

Anatomy.—The external carotid artery, which is one of the terminal branches of the common carotid, arises on a level with the upper border of the thyroid cartilage and runs to the level of the neck of the condyle of the lower jaw. At its point of origin it is covered only by skin, platysma and fascia, and the edge of the sterno-mastoid, but as it ascends it passes beneath the digastric and stylo-hyoid muscles and into the parotid gland. The glosso-pharyngeal nerve, styloid process, and stylo-pharyngeus muscle lie between the external and internal carotid arteries. The hypoglossal nerve crosses the vessel just below the digastric muscle, and the facial and lingual veins cross it a little below the nerve. The first branch is the superior thyroid, which arises from the very beginning of the trunk. The lingual arises on a level with the greater cornu of the hyoid bone. The facial and occipital take origin above the lingual. Each of them can be ligated through the incision of this operation.

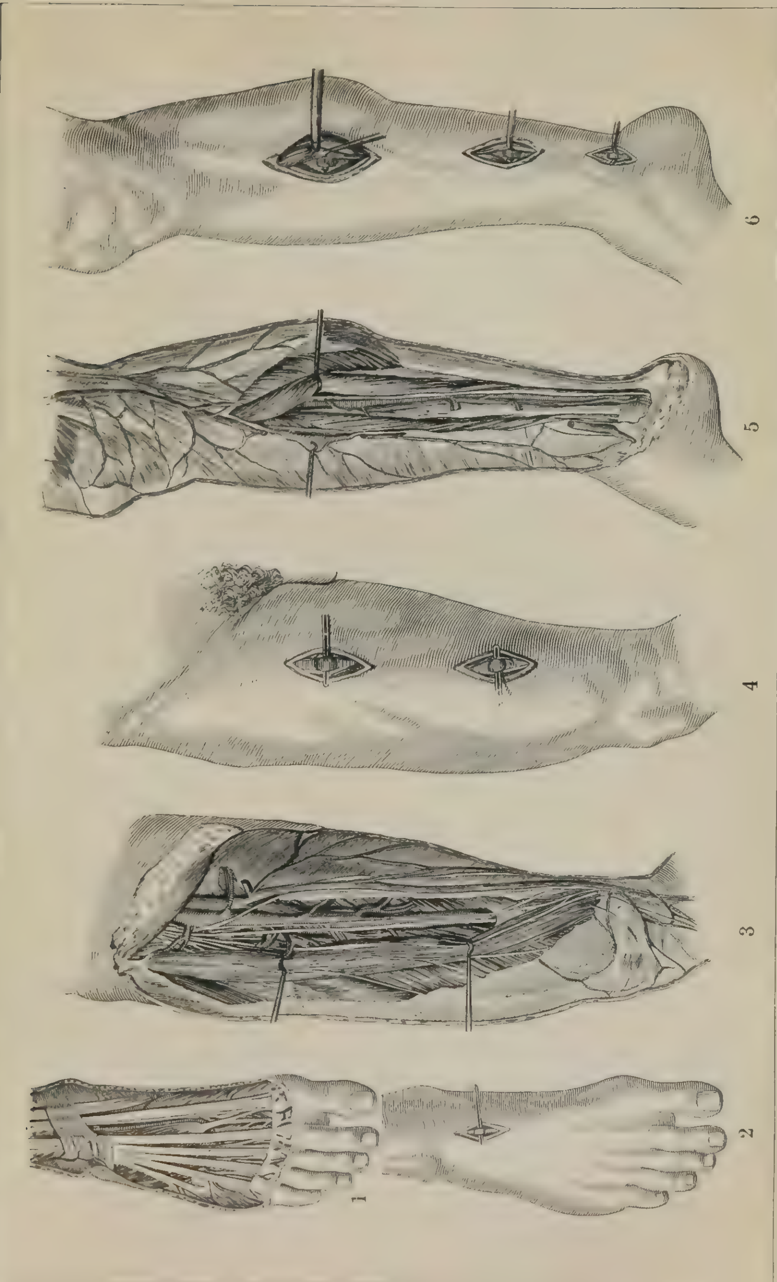
Operation.—The *position* is the same as that for the common carotid. The spot of electïon is between the superior

thyroid and the lingual. Make an incision three inches long in the arterial line, from near the angle of the jaw to opposite the middle of the thyroid cartilage, cut through skin, platysma, and deep fascia, and retract the sterno-cleido mastoid outward. Look for the digastric muscle, find the hypoglossal nerve, and feel for the greater cornu of the hyoid bone. Open the sheath a little below the hyoid cornu and pass the needle from without inward, being certain not to include in the ligature the superior laryngeal nerve.

Internal Carotid Artery.—The *line* of the internal carotid is parallel with and half an inch external to the line for the external carotid.

Anatomy.—The internal carotid artery, the other terminal branch of the common carotid, arises on a level with the upper border of the thyroid cartilage and enters the carotid canal. The first inch of the artery is the only point where a ligature is ever applied, this point being covered only by skin, platysma, fascia, and sterno-mastoid; higher up it is more deeply placed. It rests upon the vertebræ and the rectus capitis anticus major muscle. The internal jugular vein is in the same sheath and external to the artery; the pneumogastric is in the same sheath, between the artery and the vein, but posterior to both. The superior cervical ganglion of the sympathetic lies behind the origin of the internal carotid, and between the ganglion and the artery is the superior laryngeal nerve.

Operation.—In this operation the *position* is the same as in ligation of the external carotid. Incision as for the external carotid, except that it is half an inch external. The sterno-cleido-mastoid is drawn outward, the external carotid artery is found and drawn inward, the internal carotid is found and drawn outward, and the needle is passed from without inward. The internal carotid is known by its more external position and by the fact that it gives off no branches.



1, Anatomy, 2, Ligation, of the Dorsalis Pedis Artery. 3, Anatomy, 4, Ligation, of the Femoral Artery 5, Anatomy, 6, Ligation, of the Posterior Tibial Artery. (From Bernard.)

Lingual Artery.—*Anatomy* (Pl. 5, Fig. 3).—The lingual artery arises from the external carotid opposite the greater cornu of the hyoid bone, passes beneath the digastric and stylo-hyoid muscles, reaches the margin of the hyoglossus, passes under that muscle, and emerges from under it to run along the under surface of the tongue. The place of election for ligation is where the artery is beneath the hyoglossus muscle and rests upon the genio-glossus. Its guide is the hypoglossal nerve, which lies upon the muscle, but at a slightly higher level than the artery.

Operation.—In this operation (Pl. 5, Fig. 4) the *position* is recumbent with the shoulders raised and the face turned away from the side to be operated upon. The surgeon should stand upon the affected side. A curved incision is made from a little external to the symphysis of the lower jaw, downward and outward, to just above the greater cornu of the hyoid bone, and upward and outward to just in front of the facial artery at the lower edge of the lower jaw. Incise the skin, the superficial fascia and platysma, and the deep fascia. Clear the submaxillary gland and retract it well upward. Divide the fascia below the gland by a transverse incision. Find the posterior edge of the mylo-hyoid and the bellies of the digastric. Catch one of the digastric tendons and have it hooked down and out (Treves). Clear the hyoglossus muscle with a director; find the hypoglossal nerve and ranine vein and draw them a little upward. Divide the hyoglossus muscle transversely a little above the hyoid bone and below the level of the hypoglossal nerve, find the artery, and pass the needle from above downward.

Dorsalis Pedis Artery.—The *line* of the dorsalis pedis artery is from the middle of the front of the ankle-joint to the middle of the base of the first interosseous space.

Anatomy (Pl. 6, Fig. 1).—The dorsalis pedis is a continuation of the anterior tibial artery, and it runs from the bend of

the ankle to the proximal extremity of the first interosseous space, where it divides into the dorsalis hallucis and the communicating arteries. The artery rests, from above downward, upon the astragalus, scaphoid, and internal cuneiform bones, and at its point of bifurcation lies between the heads of the first dorsal interosseous muscle. It may lie in some persons a little external to this course. It is held upon the bones by a distinct layer derived from the deep fascia. This artery is covered by skin, by superficial and deep fascia, and by the annular ligament above, and is sometimes partly overlaid by the extensor proprius pollicis muscle, and is crossed, just before its bifurcation, by the innermost tendon of the extensor brevis muscle. The inner tendon of the extensor communis digitorum is to the outer side of the vessel; the tendon of the extensor proprius pollicis is to the inner side and is a guide. The artery is ligated in the dorsal triangle of the foot—a space which is bounded above by the lower edge of the annular ligament, externally by the inner tendon of the extensor brevis, and internally by the tendon of the extensor proprius pollicis. The artery has venæ comites; the anterior tibial nerve lies, as a rule, to its inner side, and the inner division of the musculo-cutaneous nerve to its outer side in the superficial parts. The anterior tibial nerve may be found upon the artery or to its outer side.

Operation (Pl. 6, Fig. 2).—In this operation the *position* of the patient is supine with the legs and feet extended. The surgeon stands below the extremity, cutting from above downward. Make an incision two inches in length along the arterial line, beginning opposite the lower edge of the annular ligament and running along by the tendon of the extensor proprius pollicis; cut through the skin, superficial fascia, and deep fascia; have the toes extended; retract the tendon of the extensor proprius pollicis inward and the tendon of the extensor communis outward; clear the artery, find the nerve,

try and separate the venæ comites, and pass the needle from the nerve.

Anterior Tibial Artery.—To locate the *line* of the anterior tibial, find a point midway between the head of the fibula and the tuberosity of the tibia, drop one inch, and draw a line from the second point to the middle of the front of the ankle-joint.

Anatomy.—The anterior tibial artery is one of the terminal branches of the popliteal; it arises opposite the lower border of the popliteus muscle, passes forward between the two heads of the posterior tibial muscle, comes to the front of the leg through an opening in the interosseous membrane, and runs down to the middle of the front of the ankle-joint. In the upper two-thirds of its course it rests upon the interosseous membrane, to which it is fastened by firm fascia; in the lower third it lies first upon the front of the tibia and then upon the anterior ligament of the ankle-joint. For its upper two-thirds the artery has the tibialis anticus muscle just internal to it; at the junction of the middle and lower thirds the extensor proprius pollicis comes from the outside and lies either upon the artery or to its inner side for the rest of its course. Externally in its upper third is the extensor communis digitorum, in the middle third is the extensor proprius pollicis; in the lower third, the proprius pollicis having crossed, the extensor communis again. The artery is covered by skin and by superficial and deep fascia. In its upper third it is deeply set between the muscles; in its middle third it is less overlaid by muscle; in its lower third it is superficial except where it is crossed by the extensor proprius and where it is covered by the annular ligament. The artery has venæ comites. In the lower three-fourths of its course it is accompanied by the anterior tibial nerve, which in its course in the upper third of the leg is external to the artery; in the middle third it is external and

a little in front of the artery; and in the lower third it is external to or upon the artery (Pl. 5, Fig. 5).

Operations.—The ligations of the anterior tibial (Pl. 5, Fig. 6) are (1) in the lower third; (2) in the middle third; and (3) in the upper third. In all these ligations the surgeon stands outside of the extremity, cutting from above downward on the right side and from below upward on the left side.

Ligation in the Lower Third.—This operation is practically the same as that for the dorsalis pedis. Make an incision three inches long in the line of the artery and over the annular ligament. This incision is external to the tibialis anticus muscle and half an inch from the outer border of the tibia (Barker). Divide the skin and fascia, retract the tendon of the tibialis anticus inward, and the tendon of the extensor proprius pollicis, along with the tendons of the extensor communis, outward. Flex the ankle-joint and clear the artery. Draw the nerve external and pass the ligature from without inward. In order to recognize the muscles in this as in other ligations, rely largely upon the finger while the muscles are being moved.

Ligation in the Middle Third.—In this operation the procedure is similar to the above. Remember that the nerve lies upon the vessel and that the extensor proprius pollicis muscle is external. The nerve is retracted outward and the needle is passed from the nerve. A good rule for detecting the artery is to find the outer edge of the tibia and by this locate the interosseous membrane, and then, by passing out along this membrane, discover the artery.

Ligation in the Upper Third.—In this operation the *position* is the same as in the above. Make an incision three inches long in the arterial line. On opening the deep fascia, do not rely on the eye for finding the muscular interspace, as often the latter cannot be seen, and neither a white nor a yellow

line is reliable. Place the index finger deep in the wound and have the tibialis anticus and extensor communis muscles successively rendered tense by an assistant. In opening the interspace, use the handle of the knife. Relax the muscles, retract the tibialis anticus inward, and draw the extensor communis outward. Find the interosseous membrane where it is attached to the edge of the tibia, and the artery will be found upon this membrane, between the tibia and the nerve. Clear the vessel and pass the ligature from without inward to avoid the nerve.

Posterior Tibial Artery.—The *line* of the posterior tibial is from the middle of the popliteal space to a point midway between the tip of the inner malleolus and the point of the heel (Pl. 6, Figs. 5, 6).

Anatomy.—The posterior tibial is the larger of the two terminal branches of the popliteal. It arises opposite the lower border of the popliteus muscle, runs down between the deep and superficial flexor muscles to midway between the tip of the malleolus and the point of the heel, and divides into the external and internal plantar vessels. In its upper third it is very deep and midway between the tibia and fibula; in its middle third it is less deep, having passed inward; and in its lower third it is superficial. At the ankle the artery is beneath the annular ligament. From above downward the posterior tibial artery rests upon the posterior tibial muscle, the flexor longus digitorum muscle, the posterior surface of the tibia, and the internal lateral ligament of the ankle-joint. For the first inch or two of the course of the artery the posterior tibial nerve is internal; the nerve then crosses to the outer side, and remains on that side throughout the rest of its course. When the knee is partly flexed and the leg is laid upon its outer surface the artery is between the operator and the nerve and the nerve is between the artery and the table. Back of the malleolus, in the first

compartment, lies the posterior tibial muscle; in the next compartment is the flexor longus digitorum muscle; in the next are the artery and nerve; and in the most posterior is the flexor longus pollicis muscle.

Operations: Ligation back of the Malleolus.—In this operation the *position* of the patient is recumbent with the thigh abducted and the leg flexed and resting upon its outer surface. The surgeon stands to the outside. Make a two-inch semilunar incision corresponding in its curve to the malleolus and half an inch posterior to its margin. Cut down to the annular ligament, incise it, and find the artery and venæ comites. Clear the vessel and pass the needle from behind forward (to avoid the nerve, which is here posterior and external). Do not make the preliminary incision nearer the malleolus than half an inch, as the sheath of the tibialis posticus muscle would then surely be opened. In sewing up, suture the ligament (Pl. 6, Fig. 6).

Ligation in the Middle of the Leg.—In this operation the *position* is the same as in the above. Feel for the inner border of the tibia, and make an incision four inches long one inch behind the border and parallel with it, and extending through skin and superficial and deep fascia. Draw the gastrocnemius outward. Incise the soleus, but not the fascia beneath the soleus; cut this fascia, dropping the handle of the knife so that the blade will be at right angles with the plane of the tibia. Clear the artery; pass the needle from without inward (Pl. 6, Fig. 6).

The popliteal artery is now never ligated in continuity; hence the methods that may be used will not be discussed.

Femoral Artery.—The *line* of the femoral artery is from midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the inner condyle of the femur, the thigh being abducted and resting upon its outer surface (Pl. 6, Fig. 3).

Anatomy.—The femoral artery is the continuation of the external iliac trunk; it extends from the lower border of Poupart's ligament to the opening in the adductor magnus muscle, and hence occupies the upper two-thirds of the thigh. The artery for its first five inches is superficial, lying in Scarpa's triangle, which is bounded externally by the sartorius muscle and internally by the adductor longus, its base being Poupart's ligament and its floor being composed of the psoas, iliacus, pectineus, and often the adductor brevis. The artery enters the triangle as the common femoral, but after a two-inch course it divides into the profunda, which passes deeply, and the superficial femoral. The latter vessel is the one alluded to in this section.

At the base of Scarpa's triangle the vein is internal, the artery is between, and the nerve is external (V. A. N.). At the apex of the triangle the vein is posterior and a little internal. At the apex of the triangle the superficial femoral passes under the sartorius muscle and enters into Hunter's canal, which occupies the middle third of the thigh and which terminates at the opening in the adductor magnus muscle. Hunter's canal is bounded externally by the vastus internus, internally by the adductors longus and magnus, and its roof is fascia which stretches from the adductor longus to the vastus. In Hunter's canal the vein is behind the artery above, but external to it in the lower part of the canal, and is firmly attached to the artery. There may be two veins. Inside Hunter's canal, but outside the femoral sheath, is the long saphenous nerve, which crosses the artery from without inward.

A good way to remember the relation of the femoral vein with the femoral artery is to recall the fact that the relation of the vein to the artery is always contrary to the relation of the sartorius muscle with the artery: when the sartorius muscle is external to the artery the vein is internal, as at the

base of Scarpa's triangle; when the sartorius muscle is crossing in front toward the inside of the artery the vein is passing at the back to the outside, as at the apex of Scarpa's triangle; when the muscle is over the artery the vein is back of it, as in the upper third of Hunter's canal; and when the muscle is to the inside of the artery the vein is to the outside, as in the lower two-thirds of Hunter's canal. In a ligation at the apex of Scarpa's triangle the inner edge of the sartorius is the guide. In a ligation in Hunter's canal the long saphenous nerve is the guide.

Operations: Ligation of the Superficial Femoral at the Apex of Scarpa's Triangle.—In this operation the *position* is supine with the thigh and leg a little flexed, the thigh abducted, everted, and rested upon its outer surface on a pillow The operator stands to the outside of the leg. From a point corresponding to the middle of the triangle, and two and a half inches below Poupart's ligament, make a three-inch incision in the arterial line. Cut the skin and superficial fascia. The saphenous vein will not be seen unless the incision is internal to the arterial line; if this vein is seen, draw it inward. Open the fascia lata, find the inner border of the sartorius muscle, and draw it outward. The fibres of this muscle run downward and inward, thus distinguishing it from the adductor longus, whose fibres run downward and outward. Open the common sheath for the artery and vein, and then incise the individual arterial sheath. Clear the artery and pass the ligature from within outward (Pl. 6, Fig. 4).

Ligation of the Superficial Femoral in Hunter's Canal.—In this operation the *position* is the same as in the above. Make a three-inch incision in the middle third, but above the middle of the thigh, parallel with the arterial line and half an inch internal to it (Barker). Incise the skin and superficial fascia, look out for the internal saphenous vein, open the fascia lata, and find the sartorius and retract it

inward, thus exposing the roof of Hunter's canal, which is to be opened for an inch or more. Within the canal is seen the long saphenous nerve, usually upon the sheath. Open the sheath of the artery, clear the vessel, and pass the needle from without inward.

Iliac Arteries.—The *line* of the common and external iliac is from half an inch below and half an inch to the left of the umbilicus to midway between the anterior superior spine of the ilium and the pubic symphysis. The upper third of this line represents the common iliac, and the lower two-thirds the external iliac (Pl. 3, Fig. 4).

Anatomy.—The common iliac arteries arise from the aorta opposite the left side and lower border of the fourth lumbar vertebra, and extend to the upper margin of the right and left sacro-iliac joints, where they each bifurcate into an external and an internal iliac. The common iliac arteries lie upon the fifth lumbar vertebra, are covered with peritoneum, and are crossed by the ureters. In women the ovarian arteries cross the common iliacs. The common iliac veins lie to the right side of their respective arteries. The right common iliac artery has in front of it, besides the peritoneum and ureter (in women also the ovarian artery), the ileum, branches of the superior mesenteric artery, and branches of the sympathetic nerve. The left common iliac artery has in front of it, in addition to structures common to both sides (ureter, ovarian artery, sympathetic branches), branches of the inferior mesenteric artery and the sigmoid flexure with its mesocolon. The internal iliac artery runs from the sacro-iliac joint to the upper margin of the great sacro-sciatic foramen. It is very rarely ligated (only in uncontrollable hemorrhage from the gluteal or sciatic arteries). The external iliac runs from the sacro-iliac joint along the pelvic brim, upon the inner edge of the psoas muscle, to Poupart's ligament. The external iliac vein is internal to the artery. On the right side, high

up, it passes behind the artery. The external iliac has in front of it peritoneum and subserous tissue (Abernethy's fascia). The ilium crosses the right, and the sigmoid flexure the left, external iliac. The genital branch of the genito-crural nerve crosses the artery low down, and the circumflex iliac vein crosses it just before it terminates in the femoral. The spermatic vessels and the vas deferens in the male, the ovarian vessels in the female, lie upon it, low down. Sometimes the ureter crosses it high up. We find the spermatic vessels in the male and the ovarian in the female lying for a time upon the inner side of the artery.

Ligation of the Iliacs by Abdominal Section.—The best method for ligating either iliac is by abdominal section, packing away the intestines with gauze, opening the peritoneum posteriorly, and selecting the vessel to be tied and the exact spot where it is desired to apply a ligature (Hearn and other operators). In ligating either common iliac, pass the needle from right to left. In ligating the external iliac, pass the ligature from within outward.

Ligation of the External Iliac by Abernethy's Extra-peritoneal Method.—In this operation the *position* of the patient is recumbent with the thighs extended during the first incisions, but in the latter stages of the operation they are flexed a little to relax the abdominal structures, the operator standing to the outside. The surgeon will find the artery along the psoas muscle. Mark a point one inch above and one inch external to the middle of Poupart's ligament, and another point one inch above and one inch internal to the anterior superior iliac spine (Barker). Join these two points by a curved incision four inches long and convex downward. Cut the skin, the fat, the two oblique and the transversalis muscles; open the transversalis fascia, draw the peritoneum inward by a broad retractor, and look for the artery along the pelvic brim. The anterior crural nerve is seen internal

to the artery, the vein is internal to the artery, and the genito-crural nerve is upon the artery. Clear the artery near its middle and pass the ligature from within outward. In Sir Astley Cooper's ligation the inguinal canal is laid open.

XVIII. DISEASES AND INJURIES OF BONES AND JOINTS.

1. DISEASES OF THE BONES.

Atrophy of bone is a diminution in the amount of bony matter without change in osseous structure. It arises from want of use (as seen in the wasting of the bone of a stump) or from pressure (as seen in the destruction of the sternum by an aneurysm of the aorta). *Eccentric* atrophy is the thinning of a long bone from within, the outer surface being unchanged—usually a senile change. *Concentric* atrophy means a thinning of the outer surface of the shaft, causing a lessened diameter. It is usually linked with eccentric atrophy.

Hypertrophy of bone may be due to increased blood-supply (as is seen in chronic epiphyseal inflammation), the bone growing much more than does its fellow. It may arise from excessive use or from strain, as is seen in the increased size of the fibula when the tibia is congenitally absent (Bowlby).

Osteitis, or inflammation of bone, may be due to traumatism, to a constitutional malady or diathesis, to the extension of inflammation from some other structure, or to infection. In inflammation of bone the exudation flows into the Haversian canals and spaces and the canaliculi, the corpuscles of the exudate and the bone-corpuscles proliferate, embryonic tissue forms, the bone undergoing thinning (rarefaction), not because of pressure, but because of absorption by voracious leucocytes and osteoclasts. This process of rarefaction enlarges all the bony spaces, and by destroying septa throws two or more spaces into one. If the surface of a

bone inflames, the periosteum will more or less be separated by the exudation and the bone will be covered with little pits or erosions. Inflamed bone is so soft that it can readily be cut with a knife.

Osteitis may terminate in *resolution* or it may terminate in *sclerosis*, the exudate being converted first into fibrous tissue and next into dense bone with only a few small cancellous spaces. If the exudation is under the periosteum, the bone will be thickened at this point, bone stalactites marking the point of passage of the vessels. Osteitis may terminate in *suppuration*, this condition being known as "caries." In strumous osteitis caseation of the inflammatory products is very apt to arise (strumous caries). Acute osteitis may terminate in *necrosis*.

Symptoms of Osteitis and Osteo-periostitis.—As a chronic process the symptoms of osteitis are commonest in the femur. Its history usually exhibits a record of a cold or an injury. Pain is severe, boring or aching in character, deep-seated, worse at night, and aggravated by a dependent position of the part. The symptoms closely resemble those of periostitis, with which disease it is almost sure to be linked. Tenderness exists on percussion, and sometimes on pressure. Subperiosteal swelling, fusiform in shape, is noted; cutaneous œdema and discoloration are observed if a superficial bone be involved. In syphilis atrophic osteitis may attack the cranial bones and produce softening or even perforation, or osteophytic osteitis may arise, exostoses being formed. Osteo-periostitis may be acute or chronic, circumscribed or diffused, and may terminate in resolution, organization, or suppuration. It arises from cold, blows, wounds, strains, the spread of adjacent inflammation, pyogenic infection, syphilis, rheumatism, or tubercle. The symptoms are pain (which is worse at night and which is aggravated by motion, pressure, and a dependent position), swelling, œdema, and discoloration of the

soft parts. Pain in the syphilitic form is not so severe as in other varieties. Acute necrosis or diffuse periostitis, a septic inflammation of bone and periosteum, is commonest in boys about the age of puberty. It is usually due to cold, a specific fever, or injury, and generally affects the tibia or femur; the symptoms locally are severe; redness, swelling, and pain are marked; constitutionally, rigors, fever, often convulsions. Necrosis is apt to result. Pyæmia is common. Some fever always exists.

Treatment of Osteitis and Osteo-periostitis.—In syphilitic forms the treatment consists of rest, elevation of the part, the local use of iodine and mercurial ointment, and bandaging. Specific treatment is by the stomach or hypodermatically. Operation is rarely justifiable. In other forms, if the case be recent and severe, put the patient to bed, place the limb in a splint and elevate it, apply leeches, cold, and lead-water and laudanum, use a bandage, and order salines and iodide of potassium. Morphia is used for pain. If these means fail, order counter-irritation by iodine and blue ointment or blisters, and use heat locally. In severe cases take a tenotome and slit the periosteum subcutaneously to relieve tension; this procedure often instantly relieves the pain. Some cases demand a longitudinal osteotomy, which is performed by taking a Hey saw and dividing the bone longitudinally into the medullary canal. If pus forms, drain at once.

Diffuse osteo-periostitis requires early and free incisions, antiseptics, drainage, rest and elevation of the limb, and strong supporting and stimulating treatment. Amputation is sometimes demanded, as when the patient grows weaker and weaker even after incision, and when a joint is seriously involved. If the necrosis affects the entire shaft, which separates from its epiphyses, and new bone has not yet formed from the periosteum, make a subperiosteal resection of the shaft.

Chronic periostitis is usually syphilitic. A *node* is a chronic inflammation of the deep periosteal layers. Nodes occurring early in the secondary stage remain soft and soon pass away, but those occurring two years or more after infection are apt to cause a bony deposit. A node may suppurate, leaving a sinus at the bottom of which is a piece of dead bone. Gumma of the periosteum is one form of node which is apt to produce caries or necrosis.

Osteoplastic periostitis accompanies chronic osteitis and causes the deposit of new bone which undergoes sclerosis. The chief *symptom* is aching pain, which is worse when warm in bed and is aggravated by damp and wet. A swelling is found at the seat of pain (often over the tibia, ulna, clavicle, or sternum). The soft parts are uninflamed and move freely unless softening or suppuration has occurred. Tenderness is manifest.

Treatment.—For the nodes of early syphilis use mixed treatment; for the nodes of late syphilis give mercury and large advancing doses of iodide of potassium. Blisters, blue ointment, and iodine used locally, and subcutaneous division of periosteum, are of value. If suppuration occurs, open antiseptically.

Abscess of bone is always chronic, never acute. It was first described by Sir Benjamin Brodie, and is often called "Brodie's abscess." It occurs in the cancellous structure of the ends of bones—usually in the head of the tibia, sometimes in the femur or humerus. The *cause* of bone-abscess is injury which induces osteitis; bone-rarefaction forms a cavity, the inflammatory products suppurate or caseate, and the surrounding bone thickens and hardens because of growth from the periosteum. Pus is apt to break into a joint, as the joint-surface is not covered by periosteum and no barrier of bone is there formed. Suppuration of bone may induce necrosis.

Symptoms.—The symptoms are like those of osteo-periostitis, only they are localized and persistent. These symptoms are thickening of bone and soft parts, œdema and discoloration of skin, tenderness, constant pain (subject to violent exacerbations and made worse by motion, pressure, and a dependent position), and attack after attack of synovitis in the nearest joint. Fever and sweats may be noted.

Treatment.—In treating bone-abscess, trephine the bone at the point of the greatest tenderness, and if the abscess is missed, follow the advice of Holmes and perforate the wall of bone with the trephine, opening in several directions to discover the pus. If the abscess opens into a joint, trephine the bone and open and drain the joint.

Caries is a suppurative osteitis with molecular osseous destruction, though some surgeons limit the term to strumous osteitis, and others include under it all forms of osteitis with bone-destruction. Osteitis is apt to become purulent when the bone is exposed to the air, when rest is not secured, when the health of the individual is below normal, when a foreign body such as a bullet is in the bone, and when struma or syphilis exists. In this condition the embryonic tissue becomes pus, which is discharged from the softened and granulating bone, and after drainage is secured organization, sclerosis, and healing result. In these cases new bone usually forms, and a cure results.

Strumous caries, due to caseation of the product of an osteitis in a scrofulous subject, shows no tendency to self-cure, no organization or sclerosis taking place and no new bone being formed, the interior of bones, especially of the carpus and tarsus, being entirely softened and destroyed, thin shells only being left.

Caries necrotica is a condition in which small but visible portions of soft and dead bone come away in the pus; *caries sicca* is molecular death of bone without suppuration.

The caseating masses in strumous caries contain the tubercle bacillus. If a strumous collection is evacuated and infection with pus cocci occurs, genuine suppuration takes place, and constitutional infection means suppurative fever, and may mean death. Purulent osteitis may affect any bone, but caseous osteitis (strumous caries) tends to arise in cancellous structure (heads of long bones, vertebral bodies, and bones of the carpus and tarsus). Strumous osteitis is apt to cause tubercular disease in an adjacent joint.

Symptoms.—In the start the symptoms of caries are usually those of osteitis, but the first symptom noted may be a fluctuating swelling due to pus or to caseated tubercle. After a time, if not opened, the abscess breaks, voids its contents, and leaves a sinus from which runs a purulent matter which after a time becomes thin, reddish, and irritant to the skin, contains small portions of gritty bone, and has a foul smell. The opening of the sinus becomes filled with œdematous granulations. A probe introduced to the bottom of the sinus finds bone which on being struck gives a muffled note rather than the clear, sharp note of necrosis; the bone is rough, is bared, and is so soft that the probe can usually be stuck into it.

Treatment.—If syphilis exists, give iodide of potassium in advancing doses and a mild mercurial course. If tubercle exists, give iodide of iron, arsenic, cod-liver oil, and nourishing foods, and recommend a change of air. Locally, insist on rest and at once secure drainage, enlarging the opening if necessary and inserting a tube, and even making additional openings; syringe often with antiseptic fluids and dress antiseptically. If the case is seen before the abscess has opened, open it under strict antiseptic precautions. When the case is found to be chronic there arises the question of operation. Incomplete operations are worse than useless, for they may cause pyæmia, and if the case be tubercular may inaugurate

systemic diffusion of the infection. If the gouge is used, try to remove all carious bone. The diseased bone is white, crumbles up, and does not bleed; the non-carious bone is pink and vascular. Scrape away all granulations; swab out the cavity with pure carbolic acid and pack it with iodoform gauze. Instead of gouging away bone, there may be used the actual cautery or sulphuric acid (Pollock). In severe cases excision is required, and in some very rare cases amputation may be necessary. Caries of the spine is considered under *Diseases of the Spine* (p. 573).

Necrosis is the death of visible portions of bone from circulatory impediment. It is analogous to gangrene. The cause of necrosis is injury (such as the tearing off of periosteum) which deprives the bone of blood. Inflammation of the periosteum further lessens the nutrition. Acute inflammation in bone causes necrosis, the excessive exudation in the canals and spaces obliterating the blood-vessels by pressure. A thin shell of bone only may necrose from periosteal separation, or an entire shaft may die from acute osteomyelitis or diffuse infective periostitis. A fragment of dead bone is a foreign body; the healthy bone adjacent to it inflames, softens, and granulates, and this line of granulations, like the line of demarcation of gangrene, separates the dead part from the living, the white dead bone being surrounded by the red zone of granulation tissue. A bit of dead bone is called a "sequestrum," and Nature tries to cast it off. A superficial sequestrum is known as an "exfoliation."

Nature's method of casting off a sequestrum is as follows: Suppuration takes place at the line of demarcation, osteitis extends for a considerable distance around this line, the periosteum shares in the inflammation, and new bone forms. A cavity thus forms within by suppuration, and a box or case forms without by ossification, the now entirely loosened sequestrum being so encased that it cannot escape. The pus

finds its way through the new bone, and there is presented the condition so often seen by the surgeon—namely, a case of new bone known as the "involucrum," a cavity containing pus and the dead fragment or sequestrum, and a discharging sinus or "cloaca." Nature may eventually get rid of the fragment, but the surgeon should not wait.

When a portion of the bone surrounding the medullary canal dies, the condition is called "central necrosis." In some rare cases necrosis occurs without apparent suppuration, a painless swelling of bone simulating sarcoma. Mercury is a cause of necrosis. The fumes of phosphorus may cause necrosis of the lower jaw in those with decayed teeth. Traumatisms are usual causes of necrosis, but it may be produced by frost-bites and burns. Many fevers (measles, typhoid, scarlet fever, etc.) are followed by necrosis. Syphilis and tubercle are occasional causes.

Symptoms.—The symptoms of necrosis are at first those of osteitis. The abscess, when formed, opens of itself or is opened by the surgeon, and a sinus or sinuses exist as in caries. A probe introduced into the sinus strikes upon hard bone with a clear, ringing note. In superficial necrosis the discharge is slight and the probe shows the limitations of the disease. In extensive necrosis the discharge is profuse, much new bone forms, several sinuses form far apart, and the probe must pass a considerable thickness of new bone before it finds the bit of dead bone. The surgeon should not operate until the dead bone is separated from the living, until a line of demarcation forms, and until the sequestrum is loose. In youth dead bone loosens quickly, but in old age slowly. An exfoliation becomes loose sooner than a deep or a central necrosis. In diffuse periostitis the necrosed shaft loosens quickly. Necrosed particles of the upper extremity loosen more rapidly than those of the lower. Chilton states[1] that

[1] *Heath's Dictionary.*

in the young adult two or three months will be required to loosen a necrosed fragment in the lower extremity, and from six weeks to two months in the upper extremity. A loose sequestrum may be moved by the probe, and when struck gives a hollow note. In old cases of necrosis and caries amyloid disease may arise.

Treatment.—The treatment of necrosis comprises free incisions for drainage, antiseptic dressing, frequent cleansing, rest, good food, stimulants, and tonics. When the sequestrum becomes loose, enlarge the cloaca with the chisel, gouge, and rongeur, remove the dead bone with the forceps, and pack the cavity with iodoform gauze. This operation is known as "sequestrotomy." If much of a gap is left by the operation, try and fill this gap by taking flaps of skin and fastening them to the bottom, by breaking the edges of the involucrum and turning them in, or by inserting bone-chips. These chips, which are obtained from the compact part of the tibia or femur of an ox, are decalcified by being placed for a couple of weeks in a 10 per cent. aqueous solution of hydrochloric acid (which is renewed every day); they are well washed in a weak alkali and then in water, are cut into strips, are soaked for two days in a 1 : 1000 sublimate solution, and are kept in a saturated ethereal solution of iodoform. The cavity is made sterile and is well dusted with iodoform, the bone-chips are dried and inserted into the involucrum, a capillary drain is employed, the periosteum is stitched over the opening, and so are the soft parts; but if this cannot be done, iodoform packing is used to keep the chips in place. This method is due to the genius of Senn.

Acute diffuse osteo-myelitis, a diffuse inflammation of bone and marrow, is due to infection with pyogenic cocci (staphylococcus pyogenes aureus and streptococcus pyogenes; Figs. 11, 12). It may arise from a wound, such as a compound fracture, a gunshot injury, or an amputation. It may

occur when the infection has been by way of the blood. In osteo-myelitis from wound of the endosteum the medulla and cancellous tissue inflame and suppurate. The entire length and thickness of the shaft may be involved, and the periosteum becomes infiltrated, detached, and retracted from the edges of the bone-wound. The soft tissues around the bone also inflame and sometimes slough. More or less necrosis is inevitable.

The symptoms of acute osteo-myelitis from wound are—a very severe boring, gnawing, aching pain; great tenderness; deep swelling of the soft parts over the bone; the skin is healthy early in the case; a profuse offensive purulent discharge containing bone-fragments and tissue-sloughs; the periosteum is red, thick, and separated; a fungating foul mass protrudes from the medullary canal; rigors, sweats, and fever point to septicæmia or pyæmia.

Treatment.—In treating acute osteo-myelitis, the following is the approved method: Incision; curetting the medullary cavity, swabbing it out with pure carbolic acid, and packing it with iodoform gauze; drainage; antiseptic dressings; frequent cleansing; and strong supporting treatment. When the sequestrum loosens, it should be removed. Some cases require amputation.

Acute Epiphysitis.—Osteo-myelitis without a wound is called "acute infantile arthritis" or "acute epiphysitis." It affects the young, especially children of from one to two years of age, and arises at the epiphyseal line. A strain occurs at this point, inflammation follows, and a hospitable welcome is extended to pus-organisms passing through this area by means of the body-fluids. The femur and tibia are the bones most often attacked, the hip-joint or knee-joint being secondarily involved, but the shoulder, ankle, or elbow may likewise fall a victim. The youngest bone around the ossific centre first inflames, necrosis takes place, a small

sequestrum forms, and the pus around the sequestrum makes a cloaca and empties into the adjacent joint, lighting up a suppurative inflammation.

The *symptoms* of acute epiphysitis usually come on suddenly at night; the attack is generally ushered in by a chill which is followed by septic febrile temperature. It will likely be found as a cause that the patient was suddenly chilled after being overheated (sitting in a cellar on a hot day, swimming when very warm, etc.). There is severe aching pain and great tenderness near the joint; the soft parts, which at first are healthy in appearance, after a time discolor, swell, and present distended veins; the neighboring joint swells and becomes filled with pus; the periosteum and the shaft are involved for a considerable distance; each epiphysis may become affected, the shaft between being comparatively uninvolved, and the epiphyses may separate, displacement and shortening taking place. This disease is often mistaken for rheumatism because of the joint-swelling, for typhoid fever because of the fever, and in some cases for erysipelas because of the redness of the skin. This disease offers a very grave prognosis.

Treatment.—In treating acute epiphysitis, incise at once; trephine the bone at one or more points; curette; irrigate with corrosive-sublimate solution; swab out with pure carbolic acid; use iodoform plentifully; drain the joint if it contains pus; employ rest, anodynes, and strong supporting treatment. Remove dead bone when it becomes loose. Amputation may be required.

Chronic osteo-myelitis is usually linked with osteitis. It may eventuate in osteo-sclerosis with filling up of the medullary canal, or in suppuration of the cancellous tissue (Brodie's abscess). A tubercular inflammation is one form of chronic osteo-myelitis.

Osteo-malacia, or Mollities Ossium.—In this disease the

bones are partly decalcified, and consequently soften and bend. Many bones are usually involved. It is commoner beyond than before middle age, though it may occur in infancy; it is commoner in women than in men, and pregnancy seems to bear more than a casual relation to its production. In osteo-malacia the medulla increases in bulk and becomes more fatty, and the osseous matter is absorbed gradually, first from cancellous tissue and then from the compact tissue. Some observers believe this curious condition is due to lactic acid in the blood.

Symptoms.—The symptoms of osteo-malacia are as follows: many points of pain which is often thought to be due to rheumatism; deformities from twisting and bending of bone; and a large excess of calcium salts in the urine. This disease lasts a number of years, but usually causes death from exhaustion, though some few cases are arrested or cured. Fractures occur from very slight force.

Treatment.—In treating osteo-malacia in women, insist that pregnancy must not occur. Put braces and supports upon distorted limbs to prevent fracture. Advise good air, hygienic surroundings, and nourishing food. Among the medicines that can be used may be mentioned cod-liver oil, lime salts, and preparations of phosphorus.

2. Fractures.

Definition.—A fracture is a solution, by sudden force, of the continuity of a bone or of a cartilage. Clinically, under this head are placed epiphyseal separations and the tearing apart of ribs and their cartilages.

Varieties of Fractures.—The varieties of fractures are as follows:

Simple fracture is a subcutaneous fracture, or one in which no open wound admits air to the seat of bone-injury. This corresponds to a contusion of the soft parts.

Compound fracture is an open fracture, or one in which an open wound admits air to the seat of bone-injury. This corresponds to a contused or lacerated wound of the soft parts.

A primary compound fracture is one in which the breach in the soft parts is occasioned at the time of the accident, either by the direct violence of the injury or by the forcing of a bone or bones through the tissues.

A secondary compound fracture is one in which the breach in the soft parts occurs after the accident, either from sloughing of damaged tissues, from ulceration from the pressure of ill-adjusted fragments, or from the forcing of a bone or bones through the soft parts because of rough handling, neglect, or the tossing of delirium.

Complicated fracture is a fracture plus the complication of a joint-injury, arterial or venous damage, or injury to the nerves or soft parts. When a fractured rib injures the lung or when a broken vertebra damages the spine we have a complicated fracture. The term is a bad one, as it conveys no definite meaning, and is no more justifiable than it would be to speak of "complicated pneumonia" or "complicated typhoid," for we should always give a name to the complication in any case. It should be remembered that damage to the soft parts not sufficient to admit air to the seat of fracture does not make the case a compound fracture, but rather complicates a simple fracture. Remember also that these areas of tissue-destruction must be treated antiseptically, otherwise absorption of pus-elements and their deposition at the seat of injury may cause diffuse osteomyelitis.

Complete fracture is that which extends through the whole thickness of a bone or entirely across it.

Incomplete fracture is that which extends only partially through the thickness of a bone or only partially across it.

A linear, *hair*, *capillary*, or *fissured fracture*, or *a fissure*,

is a crack in a bone with very little separation. This is an incomplete fracture, but may be associated with a complete break.

A green-stick, hickory-stick, willow, or *bent fracture* is a true incomplete break. It is commonest in the forearm or clavicle, it arises from indirect force, and it is very rare after the age of sixteen. It is called "green-stick" because the bone breaks like a green stick when forced across the knee, first bending and then breaking on its convex surface. The bone, being compressed between two forces, bends, and the fibres on the outer side of the curve are pulled apart, while those on its concavity are not broken, but are compressed. In correcting the deformity the fracture is apt to be made complete. The permanent bending of a bone without a break may possibly occur in youth.

Depression-fracture occurs when a portion of the thickness of a bone is driven in by crushing. Fracture by depression is a result of the bending in of a bone (as the parietal), a fragment breaking off from the side toward which the bone is bending. A depressed fracture is complete, not incomplete, and by this term is meant an injury in which a fragment of the entire thickness of the bone is driven below the level of the surrounding surface.

Splinter- and Strain-fracture.—The breaking off of a splinter of bone (splinter-fracture) or of an apophysis constitutes an incomplete fracture. A strain upon a ligament may tear off a shell of bone, and this injury is the "strain-fracture" of Callender.

Longitudinal fracture is a fracture whose line is for a considerable distance parallel, or nearly so, with the long axis of the bone. This is common in gunshot injuries.

Oblique fracture is a fracture whose line is positively oblique to the long axis of the bone. Most fractures from indirect force are oblique.

Transverse fracture is a fracture whose line is nearly transverse to the long axis of the bone (no fracture is mathematically transverse). The general cause here is direct force. The "*fracture en rave*" (radish fracture, so called because the bone breaks as does a radish) is transverse at the surface, but not within.

Toothed or *dentate fracture* is a form of fracture in which the end of each fragment is irregularly serrated and the fragments are commonly locked together; hence the deformity is hard to correct. Most of the simple fractures from direct force are serrated.

Wedge-shaped, V-shaped, cuneated, or *cuneiform fracture* ("fracture oblique spiroïde," "fracture en V" of Gosselin, "fracture en coin") is a fracture whose line has the shape of a V, which may be entire or may want the point. It occurs at the articular extremity of a long bone, and a fissure usually arises from its point and enters the joint. If complete, it is a "comminuted fracture."

T-shaped fracture is a fracture which presents a transverse or oblique line and also a longitudinal or vertical line. It occurs at the lower end of either the humerus or femur, the transverse line being above, and the vertical line (intercondyloid) between, the condyles. If complete, it is in reality a form of comminuted fracture.

Designations According to Seat of Fracture.—Fractures are designated also according to their anatomical seats; for instance, fracture of the upper third of the shaft of the femur, fracture of the olecranon process of the ulna, fracture of the middle third of the clavicle, and fracture of the body of the lower jaw. *Intra-articular* fracture is one extending into a joint; *intracapsular* fracture is one within the capsule of either the shoulder- or hip-joint; and *extracapsular* fracture is one just without the capsule of either the shoulder- or hip-joint.

Multiple or *composite fracture* is a condition in which a bone is broken into more than two pieces, the lines of fracture not intercommunicating, or a condition in which two or more bones are broken. Multiple fractures of one bone are divided into double, treble, quadruple, etc.

Comminuted fracture is a condition in which a bone is broken into more than two pieces, the lines of fracture intercommunicating. The bone may be broken into many small fragments, may present much splintering, or may actually be ground up.

Impacted fracture is one in which one fragment is driven into the other and solidly wedged.

Fracture with crushing is an impacted fracture in which the encasing bone is so crushed and splintered that the impacting bone is not firmly held.

Pathological, *spontaneous*, or *secondary fracture* is one occurring from a very insignificant force acting on a bone rendered brittle by disease.

Ununited fracture is a term used to designate a fracture in which bony union is absent after the passage of the period normally necessary for its occurrence.

Direct fracture is one occurring at the primary point of the application of force.

Indirect fracture is one occurring at a point distant from the area of the primary application of force.

Stellate or *starred fracture* (fracture par irradiation) is one in which several fissures radiate from a centre. If the fracture be complete, it is in reality a form of comminuted fracture.

Helicoidal, *spiral*, or *torsion fracture* is a fracture resulting in a long bone from twisting.

Fracture by contre-coup is a fracture of the skull which is not at, but opposite to, the point of application of force.

Epiphyseal Separation or Diastasis.—This injury occurs

only before the age of twenty-five and is commonest at the lower end of the femur, but it is encountered also at the lower ends of the tibia and radius and at both extremities of the humerus. This injury induces deformity which is often hard to reduce, and by damaging the cartilage may retard or inhibit a further lengthening by growth of the limb.

Intra-uterine fractures are usually due to injuries of the mother's abdomen sustained toward the end of pregnancy. Some hold that they can arise as a consequence of the force of violent uterine contractions. Many so-called "intra-uterine" fractures are wrongly named, as they result from injury during delivery. In sporadic cretinism (misnamed congenital rickets) the bones are fragile and ill-ossified, and many fractures may occur *in utero.*

Causes of Fracture.—The causes of fracture are (1) exciting, immediate or direct, and (2) predisposing or indirect.

Exciting causes are (*a*) external violence and (*b*) muscular action.

External violence is the most usual exciting cause. Two forms are noted: (1) direct violence and (2) indirect force.

Fractures from direct violence occur at the point struck, as when the nasal bones are broken with the fist. In such fractures the soft parts are damaged; they may be destroyed at once in part, they may be damaged so severely that a portion sloughs, or they may be damaged so slightly that they do not lose vitality; hence fractures by direct violence may be compound from the start, may become so, or may remain simple. In compound fractures by direct violence the soft-part injury is so great that primary tissue-union cannot occur.

Fractures from indirect force do not occur at the point of application of the force, but at a distance from it, the force being transmitted through a bone or a chain of bones. Such fractures tend to occur in regions of special predilection. If they are not compound, there is no injury of the tissues

over the fracture. If they become compound by projection of fragments, primary union may still occur.

Muscular action is a rather rare cause. Fractures thus produced result from sudden or violent contraction. Bones so broken are usually diseased. Violent coughing may fracture the ribs; attempting to kick may fracture the femur; saving one's self from falling backward may fracture the patellæ; throwing a stone may fracture the humerus; and sudden extension of the forearm may fracture the olecranon process of the ulna.

Predisposing Causes.—There are two classes of predisposing causes, namely: (1) physiological, natural or normal, and (2) pathological or abnormal.

Natural Predisposing Causes.—Under this head is considered the liability to fracture possessed by individual bones because of their shape, structure, function, or position. Those predispositions occasioned by special ages are also considered. In youth epiphyseal separation is commoner than fracture, and a fracture is apt to be incomplete. Fractures are commonest between the ages of twenty-five and sixty. From two to four years of age a child is more liable to fracture than later, because he is then learning to walk (Malgaigne). The bones of the old are easily broken, but the normal lack of activity of the aged saves them from more frequent injury. Thus the predispositions of age are in part due to habits and in part to bony structure. The bones of the young, being elastic, bend considerably before they break; the bones of the old, being brittle and inelastic, break easily, but do not bend. In old age the bones become lighter and more porous, though they do not diminish in size. An absorption takes place from the interior of a bone, particularly at its articular head, the medullary canal increases in size, the cancellous spaces become notably larger, and portions of the remaining bone of the interior show

a fatty change. There is no increase in the amount of mineral salts present, as was long taught. These alterations occur earlier in women than in men.[1] The change of age is a diminution in the amount of bone present, and sometimes a fatty change in a portion of what remains. If the atrophy of bone is other than that normal to senility, it constitutes a pathological predisposing cause of fracture. Normal predisposing causes include the person's weight (which determines the force of a fall), muscular development, habits, sex, occupation, and the season of the year.

Pathological Predisposing Causes.—*Hereditary fragility* is a condition commonest among women, often existing in generation after generation, and in which condition fractures occur from an infinitely slight force. There exists in these cases bony rarefaction—in fact, a premature senility.

Nervous Diseases.—Bony nutrition is dependent on the spinal cord, and the trophic influence is probably exerted through the posterior nerve-roots (Gowers). In diseases of the anterior cornua bony growth is much interfered with; in diseases of the posterior columns, as in locomotor ataxia, a true bony atrophy bespeaks trophic disorder. Syringomyelia causes brittleness of the bones, and in paralysis agitans they are thought to break easily. Trophic changes may occur in the bones of the insane, most commonly when insanity is linked to organic disease. About one-quarter of paretic dements show undue brittleness or unnatural softness of bone.[2] The bones of maniacs are frequently fragile. In asylum practice fractures are not necessarily an indication of abuse.

Rickets.—Rickets predisposes to fracture because of altered bone-structure and the great liability to falls.

Atrophy of Bone.—This condition, as has been seen (p. 295), is normal in senility. It may arise from want of

[1] Humphrey on *Old Age*. [2] Spitzka's *Manual of Insanity*.

use, as is observed in the bedfast, in the wasted femur of hip-joint disease, and in the bones of a stump. It may arise from pressure, as when an aneurysm compresses the ribs, sternum, or vertebræ. Among other of the pathological predisposing causes are to be mentioned cancer, sarcoma, and hydatid cysts of bone, caries, necrosis, gout, scrofula, syphilis, mollities ossium, and scurvy.

Symptoms of Fracture.—*History of an Injury.*—In spontaneous fracture there may be no record of violence; for instance, when a bone breaks while turning in bed. In investigating the history, not only seek for violence, but determine exactly how the accident happened.

A sound of cracking is occasionally audible to a bystander at the time of the injury. The patient may have heard it, but very rarely does. A rupture of a tendon or a ligament produces a similar sound.

Pain is usually, but not invariably, present (absent often in rickets). Malgaigne says that in some fractures the pain is slight or absent, in others it is torturing, and in most it is severe for a time after the injury, but gradually abates unless reinduced by movement. Pain developed at the time of the accident is far less important as a symptom than that which can subsequently be produced by movement. In indirect fractures there is an area of pain at the point of application of the force, and another at the seat of fracture. Pain at the seat of fracture can infinitely be aggravated by pressure or movement and is rather narrowly localized.

Deformity or *alteration in length or outline* is due in part to swelling and in part to a change in the mutual relation of the fragments (displacement). The deformity of swelling is no aid to a diagnosis, as the same thing occurs in contusion, and it often hides some positive symptomatic distortion. The swelling is due first to blood and next to inflammatory products and pressure-œdema, and is very great in joint-frac-

tures. The deformity of displacement may be produced by the violence of the injury (as is the depression in a skull-fracture), by the weight of an extremity (as is the falling of the shoulder in a fracture of the clavicle), or by muscular action (as is the pulling upward of the superior fragment of a fractured olecranon process).

The varieties of displacement are (1) *transverse* or lateral, where one fragment goes to the side, front, or back, but does not overlap the other; (2) *angular*, the bony axis at the point of fracture being altered and the fragments forming with each other an angle; (3) *rotary*, one fragment rotating in the bony circumference, the other remaining stationary. As a rule, it is the lower fragment which turns on its long axis, rotating with it the limb below the level of the break; (4) *overlapping* or overriding, when the upper level of one fragment is above the lower level of the other fragment. It is usually the lower fragment which is drawn by the muscles above the upper, but the body-weight and sliding down in bed may push the upper below the lower. In overriding the ends are near together and the bones are usually in contact at their periphery. It is obvious that overlapping is associated with transverse displacement, as one fragment must go front, back, or to the side; (5) *penetration* or impaction is when one fragment is driven into the other, thus producing shortening; (6) *separation* of the two fragments occurs in fracture of the patella, olecranon, os calcis, certain articulations, and in some breaks of the humerus when the arm is not supported.

It is important to remember that a dislocation may produce displacement, but these two conditions may be differentiated by the observation that the displacement of fracture tends to reappear after complete reduction, while that of dislocation does not reappear. A displacement is hard to detect in a flat bone and when one of two parallel bones is broken.

Loss of function may be shown by inability to move the limb because of the break, but it is not always markedly present, though some degree invariably exists. It is slight in "green-stick" and impacted fractures (unless arising from pain or nerve-injury). A person can walk when the fibula alone is broken, and likewise in some cases of intracapsular fracture of the femur, and can often put the hand on the head in fractured clavicle (Malgaigne). The pain of any injury or the loss of power from nerve-traumatism may cause loss of movement in the limb. This symptom is of slight diagnostic value in most fractures.

Extravasation of Blood.—A contusion of the surface accompanied by skin-abrasion indicates merely the point of application of direct external violence. If contusion is extensive over a superficial bone, as the tibia or parietal, after a few hours it often simulates fracture by presenting a soft, compressible centre surrounded by a ring of hard, condensed tissues and coagulated blood. Direct external violence may merely occasion ecchymosis, and in fracture from indirect force ecchymosis may occur in a considerable area. In regard to this symptom, note that even great external violence may occasion no evident contusion or ecchymosis, and in any fracture this symptom may be present or absent. In old people extravasation of blood is frequently marked and persistent. By suggillation is meant an extravasation of blood which slowly invades wide areas of tissue and which appears at the surface only after some time, and then usually as a yellowish discoloration. Linear ecchymosis has been esteemed by some as a sign of fissure, and it often follows fracture of the fibula.

Preternatural mobility is a most important symptom, which is pathognomonic when found. The unbroken bone is nowhere mobile in continuity, and by preternatural mobility is meant that a bone is mobile in continuity or that there is abnormal-

ity in the direction or extent of joint-mobility. In some fractures this symptom does not exist (impacted, green-stick, and locked serrated fractures); in others it cannot be found (fractures of tarsus, carpus, vertebral bodies); in others it is difficult to obtain, but at times can be developed (fractures near or into many joints). To develop this symptom, try, when the case admits, to grasp the fragments and to move them in opposite directions. In fractures of the shafts of the femur or humerus, fix the upper fragments and carry the knee or elbow in various directions to develop bending at the point of fracture. In fractured clavicle, push the shoulder downward and inward. In fractures of either bone of the forearm, grasp the opposite bone with four fingers of each hand and make pressure on the suspected bone alternately with either thumb; the same proceeding being used in fractures of the leg. In fractures of the neck of the femur, note the rotation arc of the great trochanter (Desault). In fractures of the lower end of the radius, bend the hand back, and in those of the lower end of the fibula, evert the foot (Maisonneuve). In seeking preternatural mobility, remember that the elastic ribs when being forced in give a sense of bending, and that the fibula at its middle is "normally flexible" (Dupuytren). Some rhachitic bones may be bent.

Crepitus or *crepitation* is both a sensation and a sound, which indicates the grating together of the two rough surfaces of a broken bone. This symptom is of great value, but it is not always present. It is absent in locked serrated fractures, in impacted fractures, in cases where the broken ends cannot be approximated (as in overlapping), and is rare when a fractured surface is against the side, and not the broken face, of the other fragment, and is unusual in incomplete fractures. Crepitus is often absent in epiphyseal separation, in softened bones, and in fractures in or near joints, and

it may be prevented from occurring by blood-clot, fascia, or muscle between the broken surfaces. The grating found in teno-synovitis must not be mistaken for the crepitus of fracture: the former is diffused, large, soft, and moist; the latter is limited, small, harsh, and dry. The clicking of an inflamed or eroded joint and the crackling of emphysema must also be separated from bony crepitus. Crepitus of fracture may be present at one moment, but absent the next. It is often not detected during the time swelling is marked, and cannot be discovered after organization of the callus begins. In but few fractures is it needful to try and hear crepitus with the naked ear or with a stethoscope upon the part, but in doubtful cases of fractures of ribs and joints it should be tried.

The above-named symptoms are known as "direct." There are other symptoms known as "circumstantial," such as the flow of blood and cerebro-spinal fluid from the ear after some fractures of the middle fossa of the skull; emphysema of the face and epistaxis after fractures of the nasal bones; hæmoptysis and emphysema after crushes of the chest; discoloration following the line of the posterior auricular artery after fractures of the posterior fossa of the skull; and subconjunctival ecchymosis after fractures of the anterior fossa of the skull.

Diagnosis.—Examine as soon as practicable after the injury—before the onset of swelling, if possible. Expose the part completely, taking off the clothing, if necessary, by clipping it along the seams. Compare the part, by attentive scrutiny, with the same part on the opposite side. If any deformity be present, it must be ascertained that it did not exist before the accident. If the nature of the injury be uncertain, if the patient be very nervous, or if the part be acutely painful, it is better to give ether to diagnosticate, and set and dress. In injuries of the elbow-joint always anæsthetize before examination (Brinton).

A fracture is distinguished from a dislocation by its preternatural mobility, its easily-reduced but recurring displacement, and its crepitus, as against the preternatural rigidity, the deformity, difficult to reduce, but remaining reduced, and the absence of crepitus of a dislocation. Further, in dislocation the bone, when rotated, moves as one piece, whereas in fracture it does not so move; in dislocation the bony processes are felt occupying their proper relations to the rest of the same bone, while in fracture some of them present altered relations; in dislocation the head of the bone is found out of its socket, but in fracture it is felt in its place. It is important to remember, moreover, that a fracture and a dislocation may occur together, and that the rubbing of a dislocated bone against an articular edge when the joint has been roughened by inflammation simulates crepitus.

Great contusion, by inducing extreme tumefaction, may mask characteristic deformity and obscure crepitus. When only a contusion exists, pain is apt to be diffused, but if a fracture has occurred, the pain is accentuated at some narrow spot. In many cases, before he can give a certain opinion, the surgeon must wait some days until the swelling has largely subsided. In such a case it is best to assume in our treatment that a fracture exists until the contrary is known. Combat swelling by rest, lead-water and laudanum, and moderate compression.

In impaction the diagnosis is difficult. The moderate deformity is concealed by swelling, crepitus and preternatural mobility do not exist unless the fragments are pulled apart, and there is not necessarily much loss of function. A conclusion is reached largely by considering the nature, direction, and extent of the violence, the seat of the pain, and by a careful study of the most minute deformity. Fissures are hard to recognize. They rarely present any evidence of their

existence except a localized pain and a linear ecchymosis appearing after a few days.

In green-stick fractures the age, the deformity, and possibly crepitus during reduction, help in the diagnosis. Epiphyseal separations are diagnosticated by the age, the preternatural mobility, the deformity, the situation of the injury, and the absence of crepitus or the presence only of a soft crepitus. Fractures are often hard to recognize when occurring in a group of bones like those of the carpus and tarsus (which are firmly joined by dense ligaments) or in one of two parallel bones. There is not always a certainty that a fracture exists, and when, after a careful examination, there is still an uncertainty, do not prolong the efforts or use great force, but treat the case as a fracture until a cure ensues or the diagnosis becomes apparent.

Complications and Consequences.—Some of the consequences and complications of fractures are—sloughing of the soft parts, thus making the fracture compound; extravasation of blood, causing swelling or even gangrene; rupture of the main artery or vein of the limb; dislocation; œdema from pressure of extravasated blood, from inflammatory exudation, from tight bandaging, from thrombosis, or, later, from the pressure of callus; stiffness of joints from synovitis with adhesion, from displaced fragments, or from intra-articular callus; stiffness of tendons from adhesive thecitis or from the presence of callus; paralysis from traumatic neuritis or the pressure of callus upon nerve-trunks; muscular spasm; painful callus; exuberant callus; embolism; fat-embolism; pulmonary congestion; gangrene; shock; septicæmia; pyæmia; tetanus; delirium tremens; urinary retention; extensive laceration of the soft parts; rupture of a large nerve; and involvement of a joint.

Repair of Fractures.—*Simple Fracture.*—In a simple fracture the bone is broken, the soft parts are lacerated, and the

periosteum is stripped up from the fragments and nearly, but not quite, torn through ("periosteal bridge" remains). As a result of these breaks and tears blood is effused, which is presently absorbed and is not an element in the healing process. The ends of the bone-fragments inflame along with the periosteum and soft parts, exudation occurs, the adjacent area softens, new vessels form, and there results a mass of embryonic tissue known as "callus." Callus is of two kinds: the *intermediate*, *definitive*, or *permanent*—that which is directly between the fractured ends; and the *provisional* or *temporary*—that within the medullary canal (*central* callus) and external to the bone (*ensheathing* callus). This latter callus is presently converted into fibrous tissue and then into bone, the only portion passing through a cartilage stage being that which emanates from the "periosteal bridge." The amount of provisional callus (Nature's splint) depends on the amount of motion between the fragments, as motion causes inflammation and inflammation manufactures new material. The greater the range of motion allowed, the larger the amount of provisional callus. In a well-adjusted and properly-dressed fracture there is very little provisional callus. This provisional callus after a time is largely absorbed and the medullary canal may again be open (requires months or even years). An excessive amount of provisional callus may cause ossification of adjacent tendons, may unite the radius to the ulna, or may block a joint from opening just as a stone placed in a door-crack would block the opening of the door. Joints may be entirely abolished by provisional callus. Fragments, even if entirely detached, may again unite with the bone, may be surrounded by callus and induce no symptoms, or may lead to suppuration. During the first week after the fracture the clot is absorbed; at the beginning of the second week organization begins; at the end of the

third week ossification is begun, and is completed at the end of the eighth or ninth week. It takes about one year to remove the temporary callus. If callus does not get beyond the fibrous state, there is that form of ununited fracture known as "fibrous union."

Compound fractures without much destruction or bruising of soft parts, if treated antiseptically, become at once simple fractures and unite as such. If the wound is not drained and asepticized, septic inflammation occurs, pus forms, and union by granulation is the best that can be obtained. Compound fractures by direct violence will not heal by first intention because of the extensive loss of vitality of a large area of the soft parts.

Non-union of Fractures.—An ununited fracture is a fracture in which the fragments are not held together by bone. The causes are local and constitutional. The *local causes* are (1) want of approximation of fragments; (2) want of rest; (3) want of blood-supply (as seen in the heads of humerus and femur, or when a nutrient artery is torn, or when a thrombus forms in a vein near the fracture); (4) defective innervation; and (5) bone-disease. The *constitutional causes* are debility, scurvy, Bright's disease, etc. In this condition the broken ends of the bone are rounded off and the medullary canal in each fragment is closed by bone. The fragments may not be held together by any material, or they may be held by very thin and much stretched fibrous tissue (*membranous* union), or by strong, thick, fibrous tissue (*ligamentous* or *fibrous* union). When the ends of the bones come together, are held by a fibrous capsule, and move on each other, there is presented a false joint or pseudarthrosis. Such a joint may after a time secrete serous fluid for lubrication.

Treatment of Fractures.—If a man is found in the street injured, further injury must be prevented by applying,

after cutting off the clothing over the fracture, some temporary support. If an ambulance or patrol-wagon cannot be obtained, move the patient by hand. If the lower extremity be involved, an improvised stretcher (a board or a shutter) is placed on the ground beside the patient, who is placed on the stretcher, the surgeon lifting the injured limb, and the patient is then carried to the hospital and carefully transferred to a fracture-bed, or, if taken home, to a small ordinary bed, a board being placed beneath a rather hard but even mattress. The temporary appliances are now removed and a diagnosis by the methods before given is proceeded with. After determining the injury the fragments must be adjusted. This should, if possible, be done at once, because a fracture remaining unreduced may become compound, the fragments may injure important structures, and they are sure to cause intense pain. Reduction is easily effected during shock, as the muscles are in a state of relaxation. If there is great swelling, reduction may be impossible, and the part must then be supported and antiphlogistics, sorbefacients, and moderate pressure be used, avoiding ice and tight bandaging, which predispose to gangrene. Set the fracture at the first possible moment. Velpeau's axiom was to reduce fractures at once, regardless of pain, spasm, or inflammation, as reduction is their cure.

If the patient is very nervous, if the pain is severe, or if rigid muscles antagonize the efforts, then reduce the fracture under anæsthesia. In some fractures (as those of the clavicle) adjustment is effected by altering the position, and in others (as those of the femur) by extension and counter-extension; in some by tenotomy, and in some by kneading, bending, and coaptation. When extension is employed, always endeavor to get a point of counter-extension. The extension is to be made on the broken bone (if possible, in the axis of the bone), and is to be steady, not jerky nor violent. In

some cases complete reduction is impossible. This may be due to spasm, to swelling, to the catching of soft parts between the fragments, to the existence of a loose fragment, to locking, or to impaction. An impaction by rotation can generally be released, but it is sometimes undesirable to reduce it. If the fragments cannot be adjusted without violence, retain them in the best attainable position, combat the antagonistic cause, and set them properly as soon as possible.

After adjusting the fragments they must be maintained in position by some retentive apparatus. Avoid pressure over joints or bony prominences, and particularly guard against tight or improper bandaging. The circulation in the fingers or the toes must be observed as an index of circulation in the limb; hence leave these digits exposed. A retentive apparatus must prevent the re-occurrence of deformity, and not be itself productive of pain or harm. For the first few days after a simple fracture the dressing is removed every day, to make sure that deformity has not recurred, and if it does recur the fragments must at once be reset. The splints should be padded thoroughly, especially when over joints or bony prominences, and they should, if possible, fix the joints immediately above and below the break. A primary roller should *never* be used.

Some surgeons at once apply an immovable dressing. This proceeding is safe in simple fractures without much displacement or soft-part injury. This apparatus is used also in military practice, with the old and feeble whom we fear to put to bed, with the young who are very restless, and with the insane or the delirious. If, however, there is great deformity, much soft-part injury, or marked swelling, immovable dressings may induce sloughing, œdema, gangrene, or faulty union. In the above-named cases use splints for the first few days; then, if it is desirable, the immovable dressing can be applied. It is dangerous to keep old or

feeble persons long in bed, as they are prone to develop bed-sores and hypostatic pulmonary congestion. The period for the artificial retention of the fracture varies with the seat of the fracture and the age and the condition of the patient. Passive motion is to be made in most fractures in from two to three weeks, though it is sometimes made earlier to prevent ankylosis.

Prevention and Treatment of Complications.—If the soft parts are badly contused, try to prevent sloughing by rest, relaxation, and lead-water and laudanum. If superficial sloughing occurs, treat antiseptically, remembering that a superficial excoriation may admit germs which, carried by the blood or lymph, may infect the bones. If a slough leads down to the fracture, treat the case as one of compound fracture. If there be great blood-extravasation, the danger is gangrene, and the foot of the bed is to be elevated, or the extremity, to which splints and bandages are to be loosely applied, is to be raised; lead-water and laudanum is applied if there be much inflammation, and cotton-wool and hot bottles if the surface be cold. If a bleb forms, it is to be opened with a needle and dressed antiseptically. If gangrene occurs, treat by the usual rules. Bullæ with good circulation do not mean gangrene.

Œdema may be due to tight bandaging. If it is due to phlebitis, there is danger of pulmonary or cerebral embolism. In these cases elevate the limb, remove all constriction, and employ locally tincture of iodine, blue ointment, and lead-water and laudanum, and internally strong stimulation. In œdema due to weak circulation or venous relaxation, use daily frictions and firm bandaging. If the fracture involves a joint, carefully adjust the fragments, make passive motion early, and inform the patient that he will have a stiff joint.

A dislocation occurring with a fracture is reduced at once if possible. To do this, splint the limb and give ether, and

try to reduce while the limb is managed with the splint as a handle. If this fails, get the bones in the best possible position, set them, await union, and then treat the unreduced dislocation. A rupture of the main artery of the limb presents the symptoms of absent pulse below the rupture, a pulsating tumor, and an aneurysmal thrill and bruit. This condition demands that the surgeon should apply an Esmarch bandage, cut down upon the tumor, turn out the clot, and if possible ligate each end of the vessel. If these measures fail or if gangrene appears, amputate at once, above the seat of the fracture.

Inflammation is to be treated by compression, rest, lead-water and laudanum, and later by a 50 per cent. ichthyol ointment. Muscular spasm requires morphia, firm bandaging, or even tenotomy. Fat-embolism is treated by stimulants and artificial respiration. Shock, delirium tremens, urinary retention, etc. are treated according to the ordinary rules of surgery.

Treatment of Compound Fractures.—It must first be decided, in cases of compound fracture, if amputation is necessary. Amputation is demanded when the limb is completely crushed or pulpefied through its entire thickness; when extensive pieces of skin are torn off; when an important joint is badly splintered; when the main artery, vein, and nerve are torn through; and when there is violent hemorrhage from a deep-seated vessel. What is to be done is to some extent determined by the patient's age and general health. In a healthy young person, if in doubt, give the limb the benefit of the doubt and try to save it: if the artery alone is ruptured, cut down upon it and tie both ends; if the nerve is severed, suture it; if a joint is opened, drain and asepticize. If an attempt is made to save the limb, be ready at any time to amputate for gangrene, secondary hemorrhage (if re-ligation at original point and compression high up fail), extensive

cellulitis, and profuse and prolonged suppuration.[1] When it is determined to try to save the limb, the part must be cleansed thoroughly by the antiseptic method (in no injuries is this more important). The fragments are reduced, resecting if necessary, and are usually held together by silver wire, copper wire, or catgut. Thorough through-and-through drainage is established and tubes are inserted. The extremity is put in a proper position, the damaged area and its neighboring parts are enveloped in corrosive-sublimate gauze, plaster is at once applied over brackets or over a well-padded stick of wood, and in the plaster a trap-door is cut before it sets, over each end of, and around, the drainage-tube (Fig. 47).

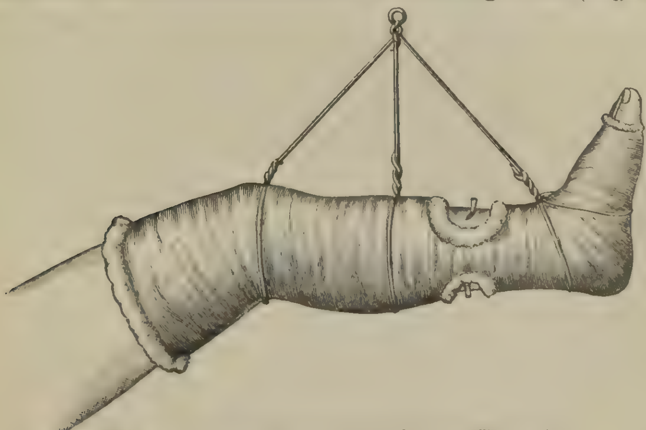


FIG. 47.—Fenestrated Plaster-of-Paris Dressing (Tiemann).

These trap-doors are covered with corrosive-sublimate gauze which is held in place by a roller. The drainage-tubes are usually removed, if suppuration does not occur, in from forty-eight to seventy-two hours. The wound is treated as any other wound.

Compound fractures may be followed by gangrene, slough-

[1] See Howard Marsh on "Fractures" in Heath's *Dictionary of Practical Surgery.*

ing, periostitis, sepsis, osteo-myelitis, necrosis, etc. The treatment of these conditions is by their well-known rules.

Treatment of Delayed Union.—When this condition exists, seek for a cause and remove it, treating constitutionally if required, and thoroughly immobilizing the parts by plaster. Orthopædic splints may be of value. Use of the limb while splinted, percussion over the fracture, and rubbing the fragments together, thus in each case producing irritation, have all been recommended. Blistering the skin with iodine or firing it has been employed. If the case be very long delayed, break the bone anew and put it up in plaster as a fresh break. If these means fail, irritate by subcutaneous drilling or scraping, or, better, by laying open the parts and then drilling and scraping at many places. Leaving acupuncture-needles in for days is approved by some, and electro-puncture is advocated by others. Old cases or cases of false joint must be treated by excision of the bony ends and fibrous tissue, securing the fragments together by periosteal sutures, by pins, by pins and plates, by ivory pegs, by screws, by silver or copper wire, or by chromicized catgut. (See *Osteotomy*.)

Vicious union may arise from a failure to coaptate the fragments, from a recurrence of displacement after reduction, or from yielding of the callus after the splints have been removed. If angular deformity results from faulty union, it can be corrected while the callus is soft. If the callus has become hard, the bone can be refractured. If faulty union occurs with overriding, an osteotomy can be performed.

Special Fractures: Nasal Bones.—The nasal bones, because of their situation, are often broken. The commonest site of fracture is through the lower third, where the bones are thin and lack support. The fracture may be compound externally or internally. The *cause* is direct violence. Dis-

placement may not occur at all, but when present it arises purely from force, and never from muscular action, no muscle being attached to these bones. If the force is from the front, the nose is flattened; if from the side, deflected and depressed. Displacement is soon masked by swelling. Crepitus can sometimes be elicited by grasping the upper part of the nose with the fingers of one hand and moving it below from side to side with those of the other hand. Preternatural mobility is valueless as a sign, because of the natural mobility of the cartilages. Diagnosis is almost impossible when deformity is absent.

The complications that may be noted are cerebral concussion, brain-symptoms from implication of the frontal bone or cribriform plate of the ethmoid, and extension of fracture to the superior maxillary or lachrymal bones. Emphysema is common, and means either a rent in the mucous membrane of Schneider or a crack in the frontal sinus. Epistaxis is usual, and is separated from the epistaxis in fractures of the base of the skull by the facts that the bleeding in the first condition is profuse, is, as a rule, soon checked, and is not followed by an ooze of cerebro-spinal fluid, whereas in the second condition it is profuse, continued, and followed by a flow of cerebro-spinal fluid. Fracture of the bony septum occasionally complicates nasal fractures, and deviation of the cartilaginous septum often takes place. The prognosis is usually good.

Treatment.—When there is no displacement, or when a displacement does not tend to be reproduced after reduction, use lead-water and laudanum for a few days if swelling exists, but employ no retentive apparatus of any kind. Order the patient not to blow his nose for ten days and to syringe it out daily with a solution of bicarbonate of sodium. If deformity be noted, correct it at once, as the bones soon unite in deformity. If the attempts at reduction are very painful or if the subject

be a child, a woman, or a nervous man, give ether or spray the interior of the nose with a 4 per cent. solution of cocaine. Reduction is effected by a grooved director in the nostril lifting up the fragments, and the fingers externally moulding them into place, or by a rubber dilator which is pushed into the nose and inflated by air or water. If moderate hemorrhage is found, check it with cold; if severe, by plugging. If flattening tends to recur, pass a Mason pin (Fig. 48) just beneath the fragments, through their periosteum, and steady them by a piece of rubber externally caught on each end of the pin or by figure-of-8 turns with silk around the ends. Leave the pin in place for five days.


FIG. 48.—Mason's Pin.

If a lateral deformity tends to recur, hold a compress over the fracture or fix a moulded-rubber splint over the nose by a piece of rubber plaster one and a half inches broad and long enough to reach well across the face, and use compression for ten days. In neither of the above cases is the nose to be blown, but in both cases it is to be syringed daily. In both cases, after dressing, if the swelling be marked, use lead-water and laudanum. In fractures rendered compound by tears in the mucous membrane, irrigate with corrosive-sublimate solution, holding the head so that the solution will not run into the mouth; wash with boiled water; plug with iodoform gauze around a small rubber catheter, which instrument permits nose-breathing; carefully remove the gauze daily and syringe. In fractures compound externally, dress antiseptically externally. Fractures of the bony septum, if showing a tendency to reproduction of de-

formity, require packing as above explained or the use of a special splint (Fig. 49). Fractures of the nasal cartilages are to be pinned in place. Fractures of the nose are entirely united in from ten to twelve days.

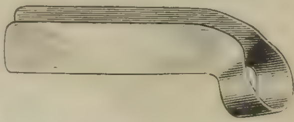


FIG. 49.—Jones's Nasal Splint (Lentz).

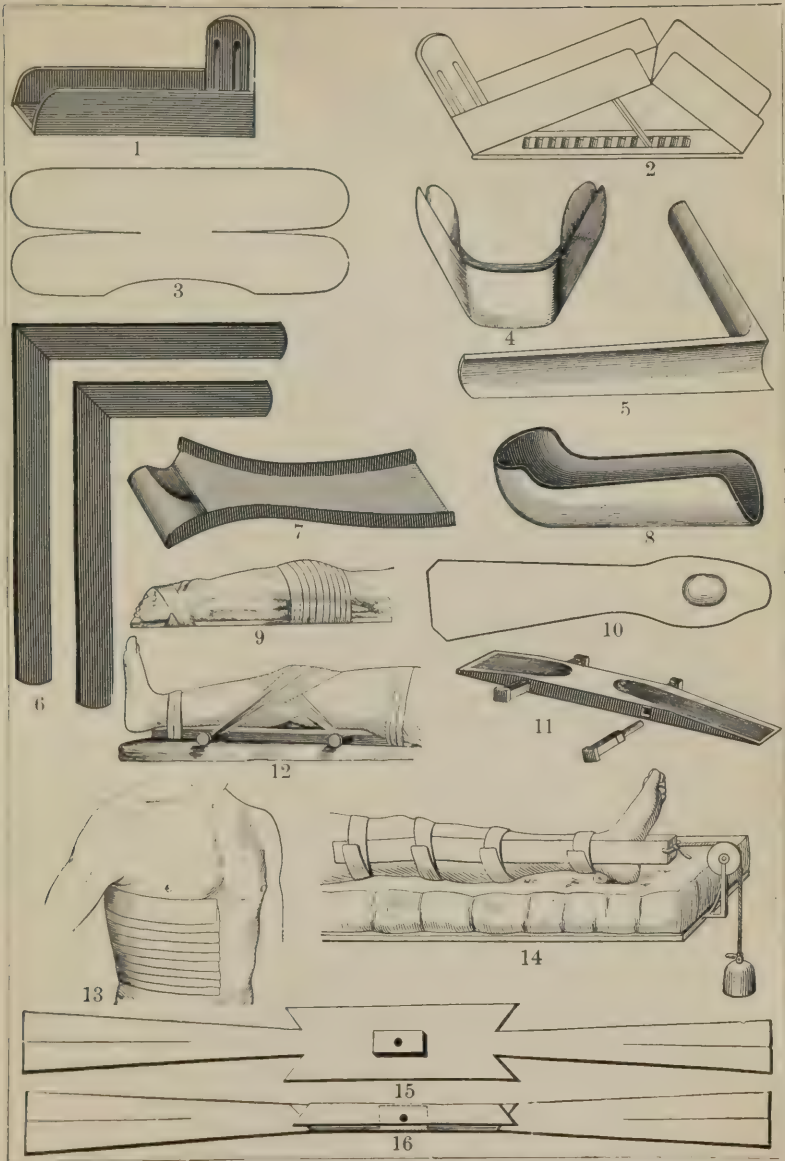
Superior Maxillary Fractures.—Although a fragile bone is rarely broken except through the alveolar border, it may be broken by transmitted force from blows on the chin or on the head when the chin is fixed; but direct violence is the usual cause, and the wall of the antrum may be crushed in. Comminution is the rule, and the injury is often compound. These fractures induce great swelling, pain, and inability to chew; mobility and crepitus may be detected. Deformity is due to the breaking force, and not to any muscle. When a portion of the alveolar arch is fractured, as may occur in pulling teeth, the fragment is depressed backward, and there exist irregularity of the teeth (some of which may be loosened) and inability to chew food. Fracture of the nasal process is apt to injure the lachrymal duct. When the antrum is broken in there are great sinking over the fracture, depression of the malar bone, and emphysema. Transverse fracture of the upper part of the body of the bone may cause no deformity. The force sufficient to break the superior maxillary bone is so great that fractures of other bones almost certainly occur, and concussion of the brain not infrequently exists. Injury of the infraorbital nerve is not unusual, causing pain, numbness, or an area of anæsthesia involving one-half of the upper lip, the ala of the nose, and a triangle whose base is one-half the upper lip and whose apex is the infraorbital foramen. There is also loss of sensation in the gums and upper teeth of the injured side. Fractures of the superior maxillary bone occasionally induce fierce hemorrhage from branches of the internal maxillary

artery, and if this occurs, watch out for secondary hemorrhage (these vessels being in firm canals).

Treatment.—If the fracture does not implicate the alveolus or if no deformity exists, apply no apparatus, but feed the patient on liquid food for four weeks. Reduce deformity, if it exists, by inserting a finger in the mouth. If the antrum is broken in, put the thumb in the mouth and push the malar bone up and back. In certain cases of deformity, make an incision at the anterior border of the masseter muscle, insert a tenaculum or aneurysm-needle, and pull the bone into place (Hamilton). Loose teeth are not to be removed: they are pushed back into place and held by wiring them to their firmer neighbors. Hemorrhage is arrested by cold and pressure. If hemorrhage is dangerously profuse or prolonged, tie the carotid.

If the line of the teeth, notwithstanding the wiring, is not regular, mould on an inter-dental splint. The usual splint for the upper jaw is the lower jaw held firmly against it by the Gibson, the Barton, or the four-tailed bandage. Every second day remove the bandage and wash the face with ethereal soap. The patient, who is ordered not to talk, is to live on liquid food administered by pouring it into the mouth back of the last molar tooth by means of a tube or a feeding-cup. Never pull a tooth to get a space, but if a tooth is lost, utilize its space for this purpose. After every meal wash out the mouth with chlorate-of-potash or boracic-acid solution to prevent foulness and the digestive disorders it may induce. Leave off the dressings in five weeks, and let the patient gradually return to ordinary diet.

In fractures compound externally, do not remove fragments, antisepticize, arrest bleeding as far as possible by ligature, by pressure, or by plugging, wire the fragments if feasible, dress with gauze, and wash the mouth with great frequency. Fractures compound internally are treated as



1. Fracture-box. 2. Double Inclined Plane Fracture-box. 3. Jaw-cup (unfolded). 4. Jaw-cup (folded). 5. Anterior Angular Splint. 6. Internal Angular Splint. 7. Bond Splint. 8. Shoulder-cap. 9. Dupuytren Splint in Pott's Fracture. 10. Agnew Splint for Fracture of the Metacarpus. 11. Agnew Splint for Fracture of the Patella. 12. Agnew Splint applied. 13. Strapping the Chest in Fractured Ribs. 14. Extension Apparatus in Fracture of the Femur. 15, 16. Adhesive Strips for Extension Apparatus.

simple fractures, except that the mouth is washed more frequently.

The malar bone is rarely broken alone. Hamilton says no uncomplicated case is on record. The malar is a strong bone resting on a fragile support, and hence it can be used as a wedge to break other bones and yet itself be unfractured. The *cause* of fracture is violent direct force. A fracture of the orbital surface of this bone causes subconjunctival hemorrhage like that encountered in fracture of the base of the skull. Protrusion of the eye may result either from hemorrhage or from crushing in of the malar bone. Chewing is apt to cause pain.

Treatment.—If no deformity exists, there is practically nothing to be done. If deformity exists, try to correct it as in fractures of the superior maxillary. As these cases are almost invariably complicated by breaks of the upper jaw, they are treated in the same manner as the latter injury. The union is complete in three weeks.

Fracture of the zygomatic arch is very rare. The *causes* are (1) direct violence; (2) indirect force (from depression of the malar); and (3) forcing of foreign bodies through the mouth. Direct violence causes inward displacement, and indirect force causes outward displacement. The symptoms are pain, ecchymosis, swelling, displacement, and difficulty in moving the jaw (because of injury to the masseter).

Treatment.—In simple fracture, give ether and try to push the arch in place. Make no incision, as depression will do no harm and the functions of the jaw will be restored. Dress with compress, adhesive strips, and crossed bandage of the angle of the jaw (Pl. 10, Fig. 1). Union will take place in three weeks.

Fractures of the inferior maxillary bone may, and most usually do, affect the body, although they occasionally occur in the rami. Any part of the body may be fractured, the most

usual seat being near the canine tooth or a little external to the symphysis (Pick). A portion of alveolus may be broken off. In fractures of the ramus either the angle, the condyloid neck, or the coronoid process may be broken. In fractures of the body the posterior fragment generally overrides the anterior. Fractures of the lower jaw are often multiple and are almost always compound, because the oral mucous membrane and alveolar periosteum are torn. The *cause* is usually direct violence. Indirect violence (lateral pressure) may fracture the body anteriorly. Fractures near the angle are always due to direct violence. Indirect violence may fracture the condyle (falls on the chin), and so may direct violence. Fractures of the coronoid are very rare, and they arise from great direct violence (usually gunshot wound or some other penetrating force).

Symptoms.—In fracture of the body preternatural mobility and crepitus generally exist. There is bleeding because of laceration of the gums; saliva dribbles constantly; the jaw is supported by the hand; great pain exists (possibly from injury of the nerve); and deformity is present, shown by inequality of the teeth if fracture is anterior to masseter, the anterior fragment going downward and backward and the posterior fragment going upward and forward. The downward displacement is due to muscular action (action of the digastric, geniohyoid, and genio-hyoglossus). The backward displacement is due to the violence. The temporal muscle draws the posterior fragment up and to the front. In fracture of the neck of the condyle the jaw is drawn toward the injured side and the condyle goes inward and forward by the action of the external pterygoid. In fracture of the coronoid process the temporal pulls the small fragment up.

Complications.—The complications are—digestive disorders and diarrhœa from swallowing foul discharges; loosening of the teeth; loosened teeth between fragments; bleeding

(usually only oozing from the gums, but there may be hemorrhage from the inferior dental); and suppuration. Necrosis may follow these fractures.

Treatment.—Remove a tooth if between fragments, but replace it in its socket after reducing the fracture. Correct deformity. Push in loose teeth and put back detached ones. Wash out the mouth with hot water to clean it and to check bleeding. If bleeding is very severe, compress the carotid for a time. The fracture can be dressed with a pad of lint over the chin and a four-tailed bandage; or put on a splint of pasteboard, felt, or gutta-percha (cut as shown on Pl. 7, Figs. 3, 4) moulded to the part, padded with cotton, and held in place by a Barton or a Gibson bandage (Pl. 10, Figs. 2, 5). If apposition of the fragments cannot be maintained by the above methods, fasten the teeth together with wire, wire the fragments themselves together, or employ inter-dental splints. The patient is to be fed on liquid food (see *Fracture of the Upper Jaw*, p. 332), the mouth is to be washed out frequently, and the dressings are to be changed every second day. The union is complete in five weeks. Though these fractures are usually compound, they do not endanger life. If they are compound, wash the mouth often with a solution of boracic acid or of chlorate of potash.

Fractures of the Hyoid Bone.—These fractures are rare injuries, and are caused by hanging, by the throat being grasped by an antagonist, and by falls in which the neck strikes some obstacle. If the bone breaks by throttling, it is its body which fractures (indirect force). Fractures by muscular action are most unusual.

Symptoms.—The symptoms are—a sensation of something breaking; bleeding from the mouth if the mucous membrane be lacerated; pain, which is worse on opening the jaws or on moving the head or tongue; difficulty in swallowing (dysphagia); muffled, hoarse, or absent voice; swell-

ing, and frequently ecchymosis, of the neck. There are observed occasionally, though rarely, harsh cough and dyspnœa, irregularity of bony contour, and crepitus. Always look into the mouth and see if there can be detected mucous ecchymosis or laceration or projection of a bony fragment. The displacement is due to the middle constrictor of the pharynx contracting. This fracture may destroy life.

Treatment.—For dyspnœa be ready to perform tracheotomy at a moment's notice. Œdema of the glottis is a great danger. Try to restore the fragments with one hand externally and with a finger in the mouth. Put the patient to bed and have him lie back upon a firm rest so that his shoulders are elevated. His head is to be thrown between extension and flexion, a pasteboard splint or collar is moulded on the neck, and a bandage is applied around forehead, neck, and shoulders to keep the head immobile. The patient must not utter a word for a week; he must at first be fed by enemata, and then for some time on liquid diet which is given through a tube early in the case. Endeavor to control the cough by opiates. A fractured hyoid bone requires about four weeks to unite.

Fracture of laryngeal cartilages is caused by direct violence, as throttling, blows, or kicks. It is rare in young persons, and is commonest when the cartilages have begun to ossify. It is a very grave injury (80 per cent. die), death arising from obstruction to the entrance of air.

Symptoms.—The symptoms, which are severe, are pain, aggravated by attempts at swallowing or speaking; swelling, ecchymosis it may be, and emphysema of the neck; cough; aphonia; intense dyspnœa; and bloody expectoration if the mucous membrane is ruptured. There can be detected inequality of outline (flattening or projection) and perhaps moist crepitus. The usual seat of the injury is the thyroid cartilage.

Treatment.—Cases without dyspnœa require quiet, avoidance of all talking, feeding with a stomach-tube, compresses and adhesive strips over the fracture, remedies to quiet cough, and a readiness to operate at any moment. In most cases dyspnœa exists, due to projection of the fragments or submucous extravasation. When there is dyspnœa, emphysema, or spitting of blood, at once practise intubation (p. 592), or, if unable to do this, open the larynx or trachea below the seat of fracture. If laryngotomy or tracheotomy is done, try and restore displaced fragments. If the fragments will not stay reduced, introduce a Trendelenburg canula or a tracheotomy-tube around which gauze is packed. Take out the packing in four days, and remove the tube as soon as the patient breathes well, when the opening is allowed to close. In these fractures feed with a stomach-tube and keep the patient absolutely quiet. Union takes place in four weeks.

Fracture of the Ribs.—The ribs, owing to their shape, elasticity, and mode of attachment, readily bend and as readily recover their shape, thus standing considerable force without breaking. Notwithstanding these facts, the situation of the ribs so exposes them that in sixteen per cent. of all cases of fractures noted by Gurth these bones were involved. In children this injury is rare and is most usually incomplete; it is common in adults and the aged, and in them is generally complete. It is more frequent among men than among women. The ribs most commonly broken are from the fifth to the ninth, the seventh being the most usual sufferer. The eleventh and twelfth ribs are seldom broken. A rib may be broken in several places, and several ribs are often broken at the same time. These fractures may be compound either through the skin or through the pleura, a damaged lung permitting pneumothorax; but compound fractures are very rare except from bullet-wounds.

Causes.—Direct force, as buffer accidents, blows with heavy instruments, or being jumped on while recumbent, may produce these injuries. A fracture from direct violence occurs at the point struck, and the ends, projecting inward, are apt to damage the viscera. *Indirect* force, as great pressure or blows which exaggerate the natural bony curves, tends to produce fractures near the middle of the ribs or in front of their angles and to force the ends outward. A number of ribs are apt to be broken. Muscular action, as in coughing or parturition, occasionally, but very rarely, is a cause.

Symptoms.—In connection with the history of the accident the symptoms are—acute localized pain (a stitch) on breathing, increased by pressure over the injury, pressure backward over the sternum, cough, and forcible inspiration or expiration; respiration is largely diaphragmatic, the patient endeavoring to immobilize the injured side; cough is frequent and is suppressed because of pain. Crepitus is often but not invariably found. It is sought, first, by resting the palm over the seat of pain while the patient takes long breaths; second, by placing a thumb before and behind the seat of pain and making alternate pressure; and third, by auscultation. It should be remembered that incomplete fractures are the rule in children; hence in them do not expect crepitus. Deformity is usually trivial unless several ribs are broken, because shortening cannot occur and the intercostal attachments prevent vertical displacement. Preternatural mobility may occasionally be elicited, when the region is not deeply covered with muscles, by pressing on one side of the supposed break and observing that a part of, and not the entire, rib moves. Cellular emphysema without a surface-wound is proof of rib-fracture. Bloody expectoration and emphysema mean injury of the lung. A simple uncomplicated case in a young person gives a good prognosis.

The *complications* are—additional injury, making the frac-

ture externally or internally compound; laceration of pleura, pericardium, heart, lung, diaphragm, liver, spleen, or colon; rupture of an intercostal artery; hæmothorax; cellular emphysema; pulmonary emphysema; pneumothorax and pyothorax; traumatic pleurisy; pneumonia; bronchitis; congestion or œdema of the lungs.

Treatment.—In an uncomplicated case the patient is not put to bed, as breathing is easier when erect than when recumbent. Angular displacement outward is corrected by direct pressure. Displacement inward is soon corrected, as a rule, by the expansion of ordinary respiratory action, but if it is not thus corrected, etherize, the deep breathing of the anæsthetic state almost always succeeding. If ether fails and dangerous symptoms come on, incise under strict antiseptic guardianship, elevate, and drain.

After correcting any existing deformity, immobilize the injured side. Direct the patient to raise his arms above his head, to empty his chest by a forced expiration, and to keep it empty until a piece of rubber plaster (two inches wide) is forcibly applied seven or eight inches below the fracture and reaching from the spine to the sternum. The patient is now allowed to take a breath and is directed to empty the chest again, another piece of plaster being applied, covering the upper two-thirds of the width of the previous strip. This process is continued until the side is strapped well above and well below the fracture (Pl. 7, Fig. 13). Over the plaster light turns of an inelastic spiral bandage are carried, or preferably a figure-of-8 bandage of the chest, the turns crossing over the seat of injury. About once a week the plaster is removed and fresh pieces applied after rubbing off the chest with soap liniment, drying, and anointing excoriations with an ointment of oxide of zinc. The dressing is worn for three or four weeks. The patient avoids cold, damp, and draughts. The diet is to be nutritious but non-stimulating, and any

cough is at once attacked by opiates and expectorants. A person with this injury who has reached the age of sixty must take stimulant expectorants (ammonii carb., grs. x, in infus. senegæ, ℥ss, t. in d.) or employ a steam-tent several times a day. The old method of treatment, in which the chest was included in a forcibly-applied broad rib roller, is not to be used except as a temporary expedient; it compresses the entire chest, causes pain and dyspnœa, and tends to loosen and slip.

Fracture of the ribs complicated with visceral injury is highly dangerous, and requires confinement to bed. The treatment is that of the visceral injury. If there be bloody expectoration, apply adhesive strips as above indicated, put the patient to bed reclining on a bed-rest, keep him quiet, subdue the circulation, and employ opium, diaphoretics, and expectorants (a good mixture consists of squill, ipecac, ammonium acetate, and chloroform; opium is given separately). Inflammations of the lung or the pleura, fortunately, are apt to be localized, and are treated as are ordinary inflammations of these parts. In laceration of an intercostal artery, incise and try to ligate; if unable to ligate, resect a rib and apply a ligature. If the signs point to internal bleeding, resect a rib, search for the bleeding point, and ligate. Emphysema usually soon disappears, but if it does not, open the cellular tissue, dress antiseptically, and employ pressure. When there arises a sudden attack of dyspnœa, which is prone to happen in these cases, and in which there are a blue face and a laboring pulse and suffocation seems imminent, bleed the patient almost to syncope.

Fracture of the costal cartilages is not a common occurrence, even in the aged. Such fractures occur either through the cartilages or through their points of junction with the ribs. These injuries generally arise from direct violence, the cartilage of the eighth rib being most prone

to suffer. Indirect force (such as a blow upon the shoulder) is occasionally the cause, but when it is the cause some other injury is apt to be noted. Muscular action is a possible cause.

Symptoms.—Displacement is often absent, but if present it is forward or backward of either fragment, and is due chiefly to the force of the injury, but partly, it may be, to muscular action. When displacement is absent crepitus will not often be found; in fact, crepitus is usually absent in these injuries. Localized pain, swelling, and ecchymosis are noted. Preternatural mobility may or may not be detected. Union by bone is to be expected.

Treatment.—If displacement exists, try to reduce it. If the fragment is displaced backward, reduce by deep inspirations; if the fragment is displaced forward, reduce by pulling back the shoulders. In this attempt failure is the rule, and the surgeon should then adopt Malgaigne's expedient of applying a truss over the projection for a day or two. Dress and treat the case as if a rib were broken, removing the dressings in four weeks.

Fracture of the Sternum.—The sternum may be broken, along with the ribs and spine, from great violence. Fractures of the sternum alone are infrequent, because the bone rests on a spring-bed of ribs. Fractures of the sternum may be simple or compound, complete or incomplete, single or multiple. The most usual injury is a simple transverse fracture at or near the gladio-manubrial junction, at which point dislocation may also occur. Both fracture and separation of the ensiform cartilage are very rare. The sternum may be broken along with the ribs or clavicle.

Causes.—The causes of fracture of the sternum are—*direct* force, as by falls of embankments or of walls, by car-crushes, or by the passing of a cart-wheel over the body; *indirect* force, as by falls upon the head, thus driving the

chin against the chest; by falls upon the feet, the buttocks, or the shoulder; by forced flexion or extension of the body over an edge or angle (as may occur during labor-pains).

Symptoms.—In fracture of the sternum displacement is not always present, but when it does occur the lower fragment is apt to go forward; displacement may, however, be transverse or angular, or there may be overriding. The posterior periosteum, which rarely tears, limits displacement, but some deformity can, as a rule, be detected. The history of the nature of the accident has a valuable bearing upon the question of diagnosis. The position assumed by the patient is with the head and body bent forward, as attempts to straighten up cause much suffering. There is fixed and localized pain, increased by deep respiratory action, by body-movements, or by cough. Crepitus is sought for by auscultation and by placing the hand over the injury and directing the patient to make quick respirations. Mobility may become manifest on external pressure, during respiration, or while attempts are being made to bring the body erect. Respiration in these cases is usually much interfered with. It is not important to separate diastasis from fracture.

Complications.—Other fractures generally complicate fracture of the sternum, and laceration of the pleura or pericardium and hemorrhage into the anterior mediastinum may exist. Abscess of the mediastinum and necrosis of the sternum may appear as late consequences. The *prognosis* is good in uncomplicated cases.

Treatment.—The deformity attending fracture of the sternum is to be corrected, if possible, by external pressure. If overriding is found, effect reduction by bending the body back over a firm pillow and ordering deep respiration; if this method fails, give ether and then bend the patient back. The deformity, if reduced, tends to recur, but the bones unite well in deformity and no great harm results. The

fragments should not be cut down on or hooked up unless there be internal injury. After reducing the deformity, cover the front of the chest with adhesive strips extending laterally from one axillary line to the other and vertically from well above the fracture down to the ensiform cartilage. Place over this covering an anterior figure-of-8 of the chest. In some cases, where deformity recurs after reduction, a circular bandage of the chest is applied and the shoulders are pulled strongly back with a posterior figure-of-8 bandage. The plaster is to be renewed once a week.

Some surgeons treat these cases by means of a large compress held by adhesive plaster and a broad tight roller. The patient, however dressed, is put to bed and reposes erect or semi-erect on a bed-rest. This position favors easy respiration and antagonizes the tendency to displacement. The diet should be light, nutritious, and non-stimulating. The patient is convalescent in four weeks, and the plaster is permanently taken off in five weeks. When the ensiform cartilage is so bent in as to cause intense pain or to injure the stomach, it should be incised and resected. Œdema of the skin and fever, if they appear, indicate pus, in which case an incision is made at the edge of the sternum and the pus-cavity is irrigated, drained, and dressed antiseptically.

Fractures of the Pelvis.—In some of the indicated fractures serious injury of the pelvic contents is apt to be found.

Fracture of the False Pelvis.—Fractures of this region are seldom dangerous unless comminuted. There may be fracture of the iliac crest or of the anterior superior spine, or the line of fracture may traverse the entire length of the flanged-out ilium, or the bone may be comminuted with the association of grave visceral damage. The anterior superior and posterior superior spines may be broken off.

Causes.—The cause of fracture of the false pelvis is generally violent *direct* force, as the passage of a wagon-wheel,

the fall of a wall, the kick of a mule, or the force of car-crushes. Violent contraction of the rectus muscle may tear off the anterior inferior spine of the ilium.

Symptoms.—In fracture of the false pelvis the history of violent force is noted. The patient leans toward the injured side. Pain exists, which is aggravated by movements (particularly by bending forward), by coughing, or by straining to empty the bowels or the bladder. Ecchymosis and swelling are manifest. Crepitus and preternatural mobility are detected by moving the crest. Deformity is very rarely present. Cases uncomplicated by visceral injury make good recoveries.

Complications.—The fracture may be, but rarely is, compound, as the parts are well protected with muscles. The colon may be injured when comminution has taken place.

Treatment.—In treating fracture of the false pelvis, put the patient on a fracture-bed, raise the shoulders, and put a binder about the pelvis, or encase the pelvis with broad pieces of rubber plaster, or employ the belt or girdle. Place the knees over two pillows so as to semiflex the legs and thighs, and tie the knees together. To restrain thigh-movements it may be necessary to encase a restless patient with splints or bind him to sand-bags. If the binder displaces the fragments or causes pain, abandon it and trust to position. The dressings can be removed in six weeks, and the patient is allowed to get up in eight weeks. In compound fractures of the false pelvis, asepticize, drain and dress, put on a binder, and direct the same position to be maintained as for simple fractures.

Fractures of the True Pelvis.—The most usual seat of these fractures is through the obturator foramen, the ascending ischial and horizontal pubic rami being broken. A fracture may occur near the symphysis pubis, the symphysis may be separated, a break may run near to or into the sacro-iliac joint, the same fracture may occur on each side of the body of the pubis, and the fracture may be multiple. Frac-

tures of the acetabulum and of the tuberosity of the ischium may occur. Before the seventeenth year the innominate bone may be broken into its three anatomical segments. These injuries are highly dangerous because of the damage which is apt to be inflicted on the pelvic contents. There may be rupture of the bladder or membranous urethra and injury of the vagina, the rectum, the uterus, or the small gut. The *cause* of pelvic fracture is violent force, direct or indirect. Front force tends to produce direct, and side force indirect, fracture.

Symptoms.—In pelvic fracture there is a history of violent force. There are great shock, ecchymosis which is possibly linear, swelling, and intense pain increased by attempts at motion, coughing, and straining. There is also inability to sit or to stand. Mobility becomes obvious on grasping an ilium in each hand and moving them. Crepitus may be noticed by this manœuvre or by moving an ilium with one hand, a finger of the other hand being inserted in the rectum or in the vagina. In making movements for diagnostic purposes, be very gentle, as rough manipulation permits of injury by sharp fragments. There may be doubt as to whether crepitus is to be referred to pelvic fracture or to fracture of the neck of the femur; in this case follow the rule of Mr. John Wood:[1] "The surgeon grasps the femur with one hand and places the other firmly upon the anterior superior iliac spine or crest or upon the pubes; then, on moving the femur and abducting it freely, if a crepitus be detected, it will be felt the more distinctly by that hand which rests on or grasps the fractured bone."

Injury of the bladder or urethra is made manifest by retention of urine, extravasation of urine, hæmaturia, etc. Bleeding from the vagina or the rectum points to a laceration of the part by a fragment. Intestinal injury induces

[1] *Lancet*, 1865, vol. ii. p. 347.

septic peritonitis. Fractures of the brim of the acetabulum permit dorsal dislocation of the femur to occur, which dislocation will not remain reduced. The acetabulum may be broken by falls upon the feet, and when its base is broken the injury can only be guessed at if displacement does not take place. If the head of the femur be driven through the acetabulum into the pelvis, the injury is very grave; there is then found shortening, adduction, and semiflexion of the thigh, absence of the prominence of the great trochanter, and more capacity for movement than is noted in dislocation. Fracture of the ischium rarely occurs alone.

Treatment.—In treating pelvic fractures, endeavor to restore the parts to a normal position, employing external manipulation and inserting a finger in the rectum or in the vagina. If reduction is difficult, give ether. Use a catheter before dressing, to detect any bladder-injury. Treat as in fractures of the false pelvis, attending carefully to visceral injuries. If urinary extravasation occurs, effect a perineal section. If peritonitis develops, perform a laparotomy. All visceral injuries are treated by general rules. Remove the dressings in six weeks, and allow the patient to be about in twelve weeks. In fracture of the acetabulum, if the limb be shortened, give ether and reduce. Treat these fractures in the same way as intracapsular fractures of the femur (p. 372). Fractures of the ischium are best treated by position, the pad, and adhesive plaster.

Fracture of the Sacrum.—This injury may arise from direct force, such as a kick, but it is very rare. The sacral plexus is usually injured, and then there is paralysis in the territory of its branches.

Symptoms.—The symptoms in fracture of the sacrum are pain, frequently incontinence of feces and retention of urine, irregularity of the sacral spines, ecchymosis, and crepitus. Crepitus may be sought for with one hand externally and a

finger of the other hand in the rectum. The lower fragment goes forward and may obstruct or may tear the rectum. Paralysis may be found in the area of distribution of the sacral plexus.

Treatment.—In treating fracture of the sacrum, press the fragments into place with a hand externally and a finger in the rectum. Do not plug the rectum. Put a pad over the upper fragment, hold it with plaster or a binder, place the patient recumbent on a fracture-bed, and insert a large cushion underneath the pad. Give opium to induce constipation, which allows a fecal support to accumulate in the rectum. Use a clean catheter regularly and guard against bed-sores. Union occurs in about four weeks, when the dressing can be removed. The patient can get about again in six weeks. If urinary retention persists or if intractable bed-sores form, after eight or ten weeks cut down on the seat of injury and elevate or remove the portion of bone causing pressure.

Fractures of the Coccyx.—The coccyx may be broken or be separated from the sacrum by a fall, a blow, a kick, or the straining of parturition. Its mobility is so great, however, that it does not often break.

Symptoms.—The chief symptom of fracture of the coccyx is pain, which is much aggravated by sitting, walking, or straining at stool. If the index finger is inserted in the rectum, the displaced bone is felt; if the thumb of the same hand is also placed externally, a rocking motion will develop crepitus and preternatural mobility.

Treatment.—In treating fracture of the coccyx, reduce by external pressure and by the manipulations of a finger in the rectum. Put the patient to bed and obstruct the bowels by opium for a number of days. In four weeks the fracture should be united. If union does not take place, defecation and all movements of the coccyx will cause excruciating

pain by pressure on the last sacral nerve. This condition, known as "coccygodynia," demands a subcutaneous division of the nerve or of the muscles which move the coccyx, or a resection of the bone.

Fracture of the Clavicle.—The clavicle is more often fractured than any other bone. This fracture may occur at any age, but is notably common before the sixth year (Hulke says one-half of the recorded cases). It may be simple, multiple, comminuted, oblique, transverse, incomplete, or, very rarely, compound. Both clavicles may be broken. Fractures are most apt to occur just external to the middle, at the point where the inner or large curve meets the outer or small curve, at which junction the bone is at its smallest diameter. Fractures of the acromial end are more frequent than fractures of the sternal end and less frequent than fractures of the shaft. The *causes* of clavicle-fractures are direct violence, indirect violence, and, very rarely, the contractions of "the deltoid and clavicular fibres of the great pectoral" (Treves, from Poaillon).

Fractures of the shaft are usually due to indirect violence, as falls upon the shoulder or upon the hand of the outstretched arm. In the latter, which is the usual mode of origin, the concussion of the fall travels up and the body-weight travels down, and these two forces compress the bone, which snaps at its weakest point. Fractures from indirect force are oblique, and in children are of the green-stick form. Fractures from direct force are usually transverse and are occasionally comminuted. Fractures from muscular action have been recorded (Rubini the tenor, recorded by Melay).

Symptoms.—In fractures of the shaft the attitude of the patient is peculiar. He supports the elbow or wrist of the injured side with the hand of the sound side, and also pulls the extremity against the chest; the head is turned down

toward the shoulder of the damaged side, as if trying to listen to something in the joint, thus relaxing the pull of the sterno-cleido-mastoid muscle upon the inner fragment. The shoulder is nearer the sternum, on a lower level, and farther front than that of the sound side. Loss of function is shown by inability to abduct the arm. Considerable pain exists, which is increased by motion, by pressure, and by the extremity hanging down without support.

The deformity above noted is described by stating that the shoulder goes downward, inward, and forward (D. I. F.). The *downward* deformity is chiefly due to the weight of the arm, which pulls down the unsupported outer fragment, and is contributed to by the action of the pectoralis minor muscle. The *inward* deformity is chiefly due to the contraction of the pectoralis minor and subclavius muscles assisted by the action of the pectoralis major. The *forward* deformity is due to rotation of the outer fragment, which is brought about by the serratus magnus muscle carrying the acromion forward. In this deformity the inner end of the outer fragment is below and behind the outer end of the inner fragment, which overrides it. The inner fragment, though pulled on by the sterno-mastoid and relatively higher than the outer fragment, is really but little, if at all, elevated, marked elevation being prevented by the attachment of the rhomboid ligament. After noting the deformity, detect with the finger the irregularity of bony contour. Examine for preternatural mobility and crepitus by raising and throwing back the shoulder. In looking for these signs in children it is to be remembered that the fracture is probably incomplete. The prognosis is good, the bone uniting, but always with some shortening and inequality.

Complications.—Fractures of the shaft are rarely compound, because the sharp end of the outer fragment goes back and because of the free play the skin makes over the

bone (Pickering Pick). Both clavicles may be broken. In fractures from direct force deeper structures may be injured by fragments. Thus, injury of the brachial plexus will induce paralysis. Ribs may be broken at the same time.

Treatment.—In treating fractures of the shaft, reduce the fracture as soon as possible by throwing the shoulder upward, outward, and backward. If the patient is a girl, it is desirable to minimize the deformity. Place her upon her back on a hard bed, with a small pillow under her head, a firm and narrow cushion between the shoulders, a bag of shot resting over the seat of fracture, and the forearm lying on the front of the chest, the arm being held to the side by a sand-bag. In three weeks there will be union, practically without deformity. In a child with an incomplete fracture a handkerchief sling for the forearm, worn three weeks, is all that is needed. In complete fracture the Velpeau bandage is efficient (Pl. 13, Fig. 4). Before applying it, place lint around the chest and cotton over the elbow. Change the bandage every day for the first week, and after that period every third day. Each time it is changed, rub the skin with alcohol, ethereal soap, or soap liniment, then dry it and examine for excoriations, which, if any are found, are anointed with zinc ointment before the dressing is reapplied. The dressing is permanently removed at the end of four weeks, the arm being worn in a sling for another week. The classical apparatus of Desault is now rarely used (Pl. 13, Figs. 1–3). The posterior figure-of-8 bandage associated with the second roller of Desault, some turns being made from the elbow of the injured side to the shoulder of the well side, can be used in cases in which the forward deformity is apt to return. The apparatus of Fox, which is very useful, consists of a pad for the axilla, a sling for the forearm, and a ring for the opposite shoulder, to which ring are tied the tapes from both the pad and the sling.

The dressing of Moore of Rochester is valuable in an emergency. The four-tailed bandage is preferred by Pick. Sayre's dressing has many advocates (Fig. 50). For this there are required two pieces of rubber plaster, each piece being three inches wide and sufficiently long to go around the chest one and a half times. The end of one piece encircles the arm of the injured side just below the arm-pit; the plaster strip is pulled across the back to the other side, to the front of the chest, and returns again to the middle of the back. This procedure pulls the elbow back and throws the shoulder out. The hand of the injured side is placed on the breast of the opposite side, cotton being interposed, and the second strip of plaster runs from the elbow of the injured side and the opposite shoulder, front, around, and back, pressing the elbow forward, upward, and inward.

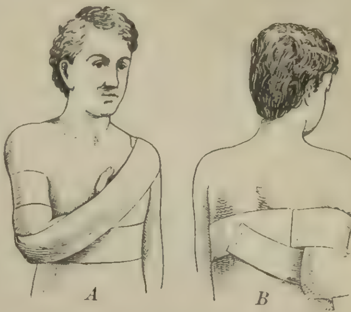


FIG. 50.—Sayre's Adhesive-Plaster Dressing for Fracture of the Clavicle (Stimson): *A*, first piece; *B*, second piece.

In any fracture, if signs indicate pressure upon vessels or nerves, the patient must be put to bed and the arm be abducted. After removing the dressings, if the shoulder is stiff, make passive movements daily; if these fail, break up the stiffness under ether or nitrous oxide.

Fracture of the acromial end of the clavicle is due to direct force. If the fracture is between the two coraco-clavicular ligaments, deformity is very slight, crepitus is elicited by manipulating with the fingers, and pain exists, but loss of function is not markedly manifest unless it is due to pain. These fractures are treated by binding the

arm to the side with the second roller of Desault, interposing cotton between the arm and the side, and hanging the hand in a sling. In fractures external to the ligaments crepitus is manifest on moving the shoulder, the outline of the bone is irregular, severe pain exists on movement, and deformity is pronounced. The deformity is due to the serratus magnus muscle rotating the scapula forward, the inner end of the outer fragment of the clavicle often coming in contact with the anterior surface of the outer portion of the inner fragment. This fracture is reduced by pulling the shoulders back over the knee, and it is kept reduced by a posterior figure-of-8 bandage. In either fracture the dressings are worn for four weeks.

Fracture of the sternal end of the clavicle is very rare. It is caused by both direct and indirect force. There are found crepitus, projection at the seat of fracture, rigidity of the sterno-mastoid muscle, and shortening of the clavicle. The inner end of the outer fragment always goes forward, and often also downward and inward. Reduce these fractures by pulling the shoulders back, and treat them by means of the posterior figure-of-8 bandage worn for four weeks.

Fracture of the Scapula.—This bone is not often broken, as it rests upon thick muscles and elastic ribs; it is freely movable, and it has attached to it a bone which easily breaks. *Fractures of the body of the bone* are due to direct violence. The *symptoms* are pain (which becomes agonizing on attempting to rotate the shoulder-blade), ecchymosis, and swelling. Crepitus is sought for by placing the hand over the bone and making movements of the arm; also by holding the point of the shoulder and lifting up the lower angle of the bone. The latter plan may display mobility. The spine of the scapula is uneven only when it itself is fractured. Examine for unevenness of the vertebral border. In frac-

tures of the body of the scapula a shoulder-cap should be applied, a gutta-percha splint must be moulded over the scapula, the arm is bound to the side, and the hand is carried in a sling. The apparatus is worn for four weeks. *Fractures of the spine of the scapula* are treated as are fractures of the body of the bone, and for the same time.

Fractures of the Neck.—Fracture of the *anatomical neck* has not been proved to exist. Fracture of the *surgical neck* is evinced by flattening of the shoulder, prominence of the acromion, and a lump in the axilla which gives crepitus on pressure upward and backward. The deformity is reduced with ease, but it at once recurs. It is treated by placing a pad in the axilla, a shoulder-cap on the shoulder, applying the second roller of Desault, and supporting the forearm and elbow in a sling. A Velpeau dressing can be used, associated with a folded towel in the axilla. The dressing is to be worn for five weeks.

Fracture of the glenoid cavity, which is not very unusual, may occur with dislocation. It arises from direct force applied to the shoulder. The existence of this fracture is determined by excluding fractures of other bones and by detecting crepitus when the arm is at right angles to the body and the humerus is pushed against the glenoid cavity, the crepitus not being found when the arm hangs by the side. *Treatment* here is by the second roller of Desault and a forearm sling for four weeks; then by careful passive movements limit ankylosis, which, if it occurs, will have to be broken up under ether or nitrous oxide.

Fracture of the acromion is often met with as the result of direct violence. Its existence is indicated by pain, by inability to abduct the arm, by flattening of the shoulder, by sudden lowering of the point of the shoulder, by mobility, and by crepitus. To treat a case of this kind, put a large pad in the axilla with the base down, bind the arm over

the pad with the second roller of Desault, lifting the elbow with turns of the roller carried over it and the opposite shoulder, thus splinting the bone in place by the head of the humerus pushing against the coraco-acromial ligaments. The dressing is to be worn for four weeks.

Fracture of the coracoid, which rarely happens alone, may arise from direct force or from muscular action. But little displacement is found. Crepitus and mobility are usually detected. Inability to shrug the shoulder inward was pointed out as a symptom by Wellington Byers. These cases are well treated by the Velpeau bandage, which is to be worn for four weeks.

Fractures of the humerus are divided into (1) fractures of the upper extremity; (2) fractures of the shaft; and (3) fractures of the lower extremity. In examining any fracture of the humerus, feel at once for the pulse, so as to ascertain if the artery has been torn; in any fracture near the head of the humerus, be certain that there is no dislocation.

1. **Fractures of the upper extremity** include (*a*) fractures of the anatomical neck; (*b*) fractures of the surgical neck; (*c*) fractures of the head, oblique and longitudinal; and (*d*) separation of the upper epiphysis.

Fractures of the Anatomical Neck of the Humerus.—The anatomical neck is the constricted circumference of the articular surface, and fractures of it, though rare, do occur, especially in the aged. The line of fracture in some cases follows the insertion of the capsule, in others it is entirely within the capsule, but in most it is without the capsule above and within the capsule below; hence the term "intracapsular" is rarely correct as a designation. The *cause* is direct violence.

Symptoms.—The symptoms in fracture of the anatomical neck are pain, swelling, ecchymosis, slight irregularity of the shoulder (which is soon hidden by tumefaction), and

inability to abduct the arm voluntarily. Deformity, as a rule, is slight or is absent, because the capsule is rarely entirely torn from the lower fragment. If deformity exists, it is due to the muscles inserted on the bicipital groove and to the coraco-brachialis, which pull the lower fragment inward and forward. Treves says that a tear of the reflected fibres of the capsule means subsequent necrosis, because this joint has no ligamentum teres. In some cases impaction occurs, the upper fragment impacting in the lower. In this condition there is very slight shortening and shoulder-flattening, no crepitus unless the tuberosity is broken off, and, as Erichsen says, the head of the bone, while it can be felt through the axilla, is not in the axis of the limb. The *prognosis* of this fracture is good for bony union (Hamilton, Pick, and R. W. Smith). A stiff joint is apt to result.

Treatment.—In the treatment of fracture of the anatomical neck, flex the arm to a right angle with the body, and carry up from the base of the fingers to above the elbow the turns of a spiral reverse bandage. Interpose lint between the arm and the side, and place a folded towel or a small pad in the axilla, tying the tapes over the opposite shoulder. Mould a shoulder-cap (Pl. 7, Fig. 8) upon the outer aspect of the arm and upon the shoulder. This cap, which is made of pasteboard or of felt, should reach below the insertion of the deltoid, cover one-half the circumference of the arm, and is to be padded with cotton. The arm with the shoulder-cap is fixed to the side by the second roller of Desault, and the hand is hung in a sling. The edges of the bandage had best be stitched. This apparatus is changed daily for the first few days, the body and arm being rubbed at each change with alcohol, soap liniment, or ethereal soap. After this period a change every third or fourth day is often enough. Passive motion is started at the end of four weeks, and the dressings are removed at the end of six weeks. In impacted

fracture do not pull apart the impaction, but apply a cap to the shoulder and fix the arm to the side for five weeks. No pad is used. The fracture unites in deformity.

Fractures of the Surgical Neck of the Humerus.—The surgical neck is the constricted portion of bone between the tuberosities and the upper line of the insertion of the muscles on the bicipital groove. Fractures in this region are usually transverse, but they may be oblique. The *causes* are—direct force almost always; indirect force occasionally; and muscular action in rare instances.

Symptoms.—The symptoms in fracture of the surgical neck are—pain running into the fingers from pressure upon the brachial plexus; crepitus and mobility on extension; and flattening, which differs from the flattening of dislocation in that it occurs farther below the acromion and that this process is not so prominent. Shortening to the extent of an inch is noted. The head of the bone can be felt in the glenoid cavity, but it does not move on rotating the arm. The upper end of the lower fragment is felt beneath the acromion, and moves on rotating the arm. The displacement is pronounced. The lower fragment is pulled upward by the deltoid, biceps, coraco-brachialis, and triceps; inward by the muscles of the bicipital groove; and forward by the great pectoral; thus, the upper end of the lower fragment projects into the axilla, and the elbow lies from the side and backward. Penn holds that the violence sends the lower fragment forward. The upper fragment is abducted and rotated outward, which is due, it is generally taught, to the action of the supraspinatus, infraspinatus, and teres minor muscles. In some cases displacement is forward, and in other cases it is not obvious. The lower fragment may impact into the upper, in which case the symptoms are obscure and the diagnosis is made by exclusion. If the impaction is solid and complete, there are the history of

1 Bond's Splint in Colles's Fracture; 2, Two Straight Splints in Fracture of both Bones of the Forearm; 3, Anterior Angular Splint in Fractures in or near the Elbow-joint; 4, Internal Angular Splint and Shoulder-cap in Fracture of the Surgical Neck of the Humerus; 5, Internal Angular Splint in Fracture of the Shaft of the Humerus, 6, Fracture-box in Fractures of the Bones of the Leg

direct force, the impaired movements, the slight deformity, and the absence of crepitus. In all fractures of the upper end of the humerus the distinction can be made from dislocation by feeling the head of the bone under the acromion and by noting that it does not move on rotating the arm. The *prognosis* of these fractures is good.

Treatment.—In treating a case of fracture of the surgical neck, take an internal angular splint (Pl. 7, Fig. 6) and pad it well, putting on extra padding at the points that are to rest against the palm, the inner condyle, and the axillary folds. Lay the arm and pronated forearm upon the splint. Apply a padded shoulder-cap. Fix the splint and cap in place with a spiral reverse bandage terminating as a spica of the shoulder, and hang the hand or forearm in a sling (Pl. 8, Fig. 4). The dressing is to be worn for five weeks, and the rules to be followed in changing it are the same as in fractures of the anatomical neck. Motions are to be made after four weeks to keep the shoulder from stiffening. Another plan of treatment is the same as for fracture of the anatomical neck, supporting the hand only in a sling, so as to get the extending weight of the elbow, increasing this weight in some cases by hanging to the elbow a bag of shot. In rare cases—those with strong anterior projection of the upper end of the lower fragment—apply an anterior angular splint (Brinton).

Longitudinal and Oblique Fracture of the Head of the Humerus.—By this term may be designated separation of the great tuberosity, or separation of a portion of the articular surface, together with the great tuberosity, from the shaft and lesser tuberosity (Pickering Pick, Guthrie, and Ogston). The *cause* is direct violence to the front of the shoulder.

Symptoms.—The symptoms in longitudinal and oblique fracture of the head are broadening and flattening of the shoulder with projection of the acromion. The upper frag-

ment passes up and out, and the lower fragment passes up and in to rest on the margin of the glenoid cavity below the coracoid. The elbow is drawn from the side, there is some shortening, and the patient cannot abduct his arm. If the elbow be grasped and held to the side and the arm be rotated while the other hand grasps the upper fragment, crepitus is very positive. Examination develops wide separation of the fragments. The deformity cannot be entirely corrected, because the biceps tendon gets between the fragments (Ogston), but a useful limb can usually be obtained.

Treatment.—The plan which gives the best result in treating longitudinal and oblique fracture of the head is to place the patient on his back upon a hard bed with a small firm pillow under his head, and to abduct the arm above the head, rotate it outward so that the back of the hand rests on the bed, and hold it in place by sand-bags. This position should be maintained for three weeks, at the end of which period the fracture can be dressed for three weeks more as a fracture of the anatomical neck. If the patient refuses to go to bed, treat the injury as a fracture of the anatomical neck, padding well over the tuberosities. The dressings should be worn for six weeks, passive motion being made after four weeks. In all the above injuries—in fact, in all fractures of the humerus—feel at once for the pulse, to see if the artery has been torn.

Separation of the Upper Epiphysis.—The epiphysis is united during the twentieth year, its separation being a rare accident and being produced by direct force.

Symptoms.—The chief symptom in separation of the upper epiphysis is projection of the upper end of the lower fragment inward, forward, and upward beneath the coracoid, and consequently a projection of the elbow backward and from the side. If only the lower fragment passes forward, the

elbow simply passes back. The upper end of the lower fragment is smooth and convex. Rotation of the shaft develops soft crepitus.

The *prognosis* is good for bony union, though the future growth of the limb may be impaired.

Treatment.—The treatment for separation of the upper epiphysis is a pad in the axilla, a shoulder-cap, binding the arm to the side, and hanging the hand in a sling.

2. **Fracture of the Shaft of the Humerus.**—Fracture of the shaft of the humerus is a very common accident. The *cause* is usually direct violence, such as a blow. The fracture may arise from indirect violence, such as a fall upon the elbow. Muscular action is not rarely also a cause, as in throwing a ball, in catching a tree-limb while falling, or in turning another's wrist as a test of strength (Treves).

Symptoms.—The symptoms of a fractured shaft are pain, swelling, ecchymosis, inability to move the arm, mobility, and distinct crepitus. Shortening to the extent of three-fourths of an inch occurs. The displacement varies with the situation of the fracture and the direction of the force. If the fracture is above the insertion of the deltoid, the lower fragment is pulled up by the triceps, biceps, and deltoid, and pulled out by the deltoid, and the upper fragment is pulled inward by the arm-pit muscles. In fracture below the deltoid this muscle is apt to pull the lower end of the upper fragment outward, while the lower fragment passes inward and upward because of the action of the biceps and triceps.

The *prognosis* is good, but the fact should always be remembered that ununited fractures are commoner in the humerus than in any other bone. Treves believes this to be due to entanglement of muscle between the fragments, lack of fixation of the shoulder-joint, and imperfect elbow-support. Hamilton believes that it is due to the facts that the elbow soon becomes fixed at a right angle, and that any

movement of the forearm moves the seat of fracture, and not the elbow.

Treatment.—The treatment for fracture of the humerus is an internal angular splint without the shoulder-cap. If deformity is not corrected, associate with this splint three short humeral splints instead of the shoulder-cap used in fractures near the shoulder-joint. Splints are to be worn for six weeks. Passive movements are not to be made until the fracture is well united (after six weeks), for, if made too soon, they predispose to non-union, and, as no joint is involved, ankylosis will not occur (Pl. 8, Fig. 5).

3. **Fractures of the Lower Extremity of the Humerus.**—These fractures are spoken of as fractures in, or in the neighborhood of, the elbow-joint, and they include (*a*) fracture of the external condyle; (*b*) fracture of the internal condyle; (*c*) fracture of the internal epicondyle; (*d*) fracture at the base of the condyles; (*e*) T-fracture; and (*f*) epiphyseal separation. In all injuries of the elbow-joint, give ether in making the diagnosis (Brinton).

Fracture of the External Condyle of the Humerus.—A fracture of the external condyle runs into the joint and the capitellum is usually broken off. This injury occurs oftenest in children by falling on the hand, but it may occur from direct force, and may happen to adults.

Symptoms.—The symptoms of fracture of the external condyle are pain, great swelling, impaired function, and crepitus (found on pressing or moving the condyle). Mobility may also be discovered.

Fracture of the Inner Epicondyle of the Humerus.—The inner epicondyle is an epiphysis which unites during the seventeenth year. It not infrequently breaks from muscular action or from direct violence, the fracture not involving the joint. Displacement is slight. The *outer epicondyle* does not break.

Fracture of the Internal Condyle of the Humerus.—The line of fracture of the internal condyle runs into the joint, to the trochlear surface of the humerus. The *cause* is always direct violence.

Symptoms.—In fracture of the internal condyle the fragment, accompanied by the ulna, goes upward and backward, and when the forearm is extended the ulna projects posteriorly, the lower end of the humerus being felt in front. Crepitus and preternatural mobility can be found if swelling is not too great. The space between the condyles is broader than normal and the forearm takes a bend toward the ulnar side, the carrying function of the forearm being lost (Brinton); that is, if a bucket be held in the hand, it would strike the leg.

Fracture at the Base of the Condyles of the Humerus.—This fracture is just above the olecranon and is on a higher level behind than in front. The *cause* is direct force upon the olecranon.

The *symptoms* are loss of function and pain from injury of the median or ulnar nerves. Crepitus and mobility are readily found. The lower fragment goes backward and upward by the action of the triceps, biceps, and brachialis anticus. The lower end of the upper fragment projects in front of the joint.

T-fracture of the Humerus.—This fracture is a transverse fracture above the condyles plus a vertical fracture between them. The *cause* is violent direct force applied posteriorly.

Symptoms.—The symptoms are increase in breadth of the joint, preternatural mobility, crepitus, pain, and swelling.

Fractures In or Near the Elbow-joint.—*Prognosis and Treatment.*—The prognosis for complete restoration of function is bad, and in most of these fractures some deformity and considerable stiffness are inevitable. Callus poured into

a joint acts like a stone pushed into the crack of a door: it limits or prevents motion. Give ether for diagnosis and the first dressing. If swelling is so great that the surgeon dare not apply a splint, let him rest the arm, semiflexed, upon a pillow and apply lead-water and laudanum for a day or two. The position for splinting is to be full supination, which is obtained by so placing the hand of the patient that he could easily spit into the palm (Brinton). Apply a well-padded anterior angular splint (a right-angled splint; Pl. 7, Fig. 5; Pl. 8, Fig. 3). If posterior projection exists, mould a pasteboard cup over the elbow or apply a trough. In applying the anterior angular splint, first fasten the upper end to the arm, then make extension of the elbow, and fasten the lower end of the splint to the extended forearm. This splint is to be worn for four or five weeks, removing it carefully every third day. Begin passive motion at the end of the second week. After the dressings are removed employ passive motion, massage, hot and cold douches, inunctions of ichthyol or mercurial ointment, iodine locally, corrosive sublimate and iodide of potassium internally, and direct the patient to systematically use the arm. Many surgeons at the end of the second week apply a Stromeyer splint which permits the patient and the surgeon to make some motion by means of the screw (Fig. 67). In children or in very stout people an anterior angular splint will not stay in place, in which case the arm should be put at a right angle and plaster of Paris be used. If, on removing an angular splint from any case after four weeks, non-union exists, put up the arm in an immovable splint for three or four weeks more.

Epiphyseal separation of the humerus is a not unusual accident. The inferior extremity of the humerus may be separated, or the condyles may be separated from each other and from the shaft of the bone.

Symptoms.—The symptoms are—prominence in front of the joint, caused by the lower end of the shaft of the humerus; projection backward of the olecranon; hand midway between pronation and supination. Epiphyseal separation may retard growth and produce deformity.

Fractures of the ulna comprise the following varieties: (1) fracture of the coronoid process; (2) fracture of the olecranon process; (3) fracture of the shaft; and (4) fracture of the styloid process.

Fracture of the coronoid process of the ulna occurs only as a complication of a backward dislocation or in association with other fractures.

Symptoms.—When fracture of the coronoid process is associated with a dislocation there is produced crepitus on reduction, and it is found that the deformity of the dislocation promptly returns on cessation of extension. The upper fragment may be pulled up by the brachialis anticus, and there exists an inability to flex the forearm completely. The position is one of extension with posterior projection of the olecranon. The broken piece is felt in front of the joint.

Treatment.—The treatment is by an anterior splint whose angle is less than a right angle; the splint is to be worn for four weeks, and passive motion is to be begun in the third week. A stiff joint is probable.

Fracture of the olecranon process of the ulna is not an uncommon injury in adults. Hulke states that it never occurs before the age of fifteen, but the writer has seen in the Jefferson Hospital a girl aged fourteen with a fractured olecranon. The *cause* is direct violence or muscular action. Only a small fragment may be torn away or the greater part of the olecranon may be broken off, and the break may be comminuted or even be compound.

Symptoms.—The symptoms of fracture of the olecranon are—swelling; partial flexion of forearm; separation of frag-

ments, the upper piece being pulled up from half an inch to two inches by the triceps; the space between the fragments is increased by forearm flexion and lessened by forearm extension; there is inability to extend the arm. Bulging of the triceps above the fragments and crepitus on approximating the fragments are observed. The *prognosis* is fair, fibrous union being the rule. Some joint-stiffness usually occurs, and much ankylosis may be unavoidable.

Treatment.—The treatment calls for a well-padded anterior splint, almost but not quite straight. A perfectly straight splint is uncomfortable, and, by opening a retiring angle between the fragments and into the joint, favors non-union and ankylosis. The splint should reach from a level with the axillary margin to below the fingers. If the upper fragment does not come in contact with the lower, pull it down by adhesive plaster and fasten the strips to the splint. The author in one case employed a glove to which strings from the adhesive plaster were attached. The danger of ankylosis in this fracture is very great, and, in case it occurs in the position of extension, means an almost useless arm. Pickering Pick at the end of three weeks anæsthetizes the patient, presses his thumb firmly down upon the top of the olecranon, puts the forearm at a right angle, and applies an anterior angular splint and directs it to be worn for two weeks, passive motion being made every other day. When the splint is removed, try to obtain motion as previously directed. Non-union requires wiring of the fragments.

Fracture of the shaft of the ulna is most apt to be near the middle, is always due to direct violence, and is not unusually compound. The radius may also be broken.

Symptoms.—By running the finger along the inner surface of the bone there are detected inequality and depression; crepitus and mobility are developed; there are pain and the evidences of direct violence. The long axis of the hand is

not in a line with the long axis of the forearm, but is internal to it. If deformity exists, it is due to the lower fragment passing into the interosseous space because of the action of the pronator quadratus muscle; the upper fragment, acted on by the brachialis anticus, passes a little forward. The forearm at and below the seat of fracture is narrower and thicker than normal.

Treatment.—In treating fracture of the shaft, place the forearm midway between pronation and supination, so as to bring the fragments together and to obtain the widest possible interrosseous space; this limits the danger of ankylosis in this space. The position midway between pronation and supination is marked by flexing the forearm to a right angle with the arm and pointing the thumb to the nose. Take two well-padded straight splints, one long enough to reach from the inner condyle to below the fingers, the other from the outer condyle to below the wrist; place a long pad over the interosseous space on the flexor side of the limb, and another on the extensor side; apply the splints and hang the arm in a triangular sling (Pl. 8, Fig. 2). Passive motion is to be made in the third week, and the splints are to be worn for four weeks.

Fracture of the styloid process of the ulna is due to direct force. The displacement is obvious.

Treatment.—In treating fracture of the styloid process, push the fragment back into place and use a Bond splint with a compress for four weeks.

Fractures of the radius include the following varieties: (*a*) fractures of its head; (*b*) fractures of its neck; (*c*) fractures of its shaft; and (*d*) fractures of its lower extremity.

Fracture of the head of the radius very rarely occurs alone, but it may complicate backward dislocation of the radius and the ulna.

Symptoms.—The symptoms of fracture of the head of the

radius are crepitus on making pronation and supination, and loss of voluntary pronation and supination.

Treatment.—The treatment of fracture of the head of the radius is the same as for a fracture in or near the elbow-joint—namely, an anterior angular splint for four or five weeks, with passive motion in the third week (Pl. 8, Fig. 3).

Fracture of the neck of the radius rarely occurs alone.

Symptoms.—In this fracture the forearm is pronated and the patient is found to have lost the power of voluntary pronation and supination. Under forced pronation and supination it will be noted that the head of the radius does not move and crepitus is felt. The lower fragment, being pulled up and forward by the biceps, can be felt in front of the elbow-joint.

Treatment.—The treatment for fracture of the neck of the radius is the same as for fracture of the elbow-joint—namely, an anterior angular splint for four or five weeks (Pl. 8, Fig. 3).

Fracture of the shaft of the radius is far commoner than fracture of the shaft of the ulna. It may occur above or below the insertion of the pronator radii teres muscle. It may arise from either direct or indirect force.

Fracture of the Radius above the Insertion of the Pronator Radii Teres Muscle.—*Symptoms.*—The upper fragment is drawn forward by the biceps and is fully supinated by the supinator brevis. The lower fragment is fully pronated by the pronator quadratus and pronator radii teres, and its upper end is pulled into the interosseous space. There are crepitus, mobility, pain, narrowing and thickening of the forearm below the seat of fracture, and loss of the power of pronation and supination. The head of the bone is motionless during these movements, and the hand is prone.

Treatment.—In treating this fracture, do not put the forearm midway between pronation and supination, as this position will not bring the fragments into contact, the upper

fragment remaining flexed and supinated. To bring the lower fragment in contact with the upper, flex and fully supinate the forearm. Put the arm upon an anterior angular splint for four weeks (Pl. 8, Fig. 3), and make passive motion in the third week.

Fracture of the Radius below the Insertion of the Pronator Radii Teres Muscle.—In this variety of fracture the upper fragment is acted on by the biceps, the supinator brevis, and the pronator radii teres, and it remains about midway between pronation and supination, passing forward and also into the interosseous space. The lower fragment is acted on by the supinator longus and the pronator quadratus, the latter being the more powerful of the two, and the lower fragment is moderately pronated, its upper extremity being thrown into the interosseous space. Other symptoms are identical with those of fracture above the insertion of the pronator radii teres.

Treatment.—In treating fracture below the pronator radii teres, the forearm is flexed and is placed midway between pronation and supination; interosseous pads and two straight splints are applied as for fracture of the ulna (Pl. 8, Fig. 2). The splints are worn for four weeks, and passive motion is made in the third week.

Fracture of the shafts of both bones of the forearm is not frequently seen. It is caused by direct or indirect force.

Symptoms.—In fractures of both bones of the forearm the hand is pronated and the two lower fragments come together and are drawn upward and backward or upward and forward by the combined force of flexor and extensor muscles, shortening being manifest and a projection being detected on either the dorsal or the flexor surface of the forearm. The upper fragment of the ulna is somewhat flexed by the brachialis anticus; the upper fragment of the radius is flexed by the biceps and is pronated and drawn toward the ulna by

the pronator radii teres. The forearm is narrower than it should be (the ends of the fragments having passed into the interosseous space) and is thicker than normal (the contents of the interosseous space having been forced out). Crepitus, mobility, pain, and inequality exist, the power of rotation is lost, and on passive rotation the head of the radius does not move. The forearm is prone and semiflexed.

Treatment.—The treatment requires two straight splints and two interosseous pads, the forearm flexed to a right angle and placed midway between pronation and supination (Pl. 8, Fig. 2). The splints are worn for four weeks, and passive motion is made in the third week.

Fracture of the Lower Extremity of the Radius.—*Barton's fracture* is oblique and runs into the joint. *Colles's fracture* is a transverse or moderately oblique fracture of the lower end of the radius, between the limits of one-quarter of an inch and one and a half inches above the wrist-joint, the lower fragment mounting upon the dorsum of the upper piece. *Colles's fracture*, a very common injury, is met with more frequently in those beyond the age of forty, and oftener in women than in men. It is due to transmitted force (a fall upon the palm of the pronated hand), the force being received by the ball of the thumb and passing to the carpal bones and the edge of the radius; a fracture begins posteriorly rather than anteriorly, the force driving the fragment upon the dorsal surface of the radius. Some hold that this fracture is due to sudden traction upon the anterior ligaments, which drag upon the bone and break it at the point where the cancellous end of the radius joins the compact shaft.

Symptoms.—In Colles's fracture the hand is abducted (drawn to the radial side of the forearm) and pronated, the head of the ulna is prominent, the styloid process of the radius is raised, and the lower fragment, which mounts on the back of the lower end of the upper fragment, causes

a dorsal projection termed by Liston the "silver-fork deformity." The lower end of the upper fragment can be felt beneath the flexor tendons above the wrist. The position in deformity is produced by the force and is maintained by the action of the supinator longus and the flexor and extensor muscles, but particularly by the extensors of the thumb. Pronation and supination are lost. Crepitus, which is best obtained by alternate hyperextension and flexion, can be secured unless swelling is great or impaction exists. Crepitus on side movements is rarely obtainable. Impaction may greatly modify the deformity, though displacement generally exists to some extent, and the fragments do not ride easily on each other. The styloid process of the ulna may be broken, or the inferior radio-ulnar articulation may be separated. This latter complication allows the lower fragment to roll freely upon the upper, and the characteristic silver-fork deformity does not appear. If the styloid process of the ulna is broken, pressure over it causes great pain. If a person in falling strikes the back of the hand and a fracture of the radius occurs, the lower fragment is driven upon the front surface of the upper fragment and is felt under the flexor tendons at the wrist.

Treatment.—In treating Colles's fracture, reduce the deformity by hyperextension to unlock the fragments, by longitudinal traction, and by forced flexion. The extremity can be placed upon a Levis splint, the position maintaining reduction and the tense extensor tendons giving dorsal support. The favorite splint in Philadelphia practice is Bond's. It places the hand in a natural position of rest (semiflexion of the fingers, semi-extension of the wrist, and deviation of the hand toward the ulna). Two pads are used: a dorsal pad which overlies the lower fragment, and a pad for the flexor surface which overlies the upper fragment. A bandage is applied, the thumb and fingers being left free (Pl. 8, Fig. 1; Pl. 7, Fig. 7).

Passive motion is begun upon the fingers in three or four days, and upon the wrist during the second week. The splint is removed in three weeks, and a bandage is worn for a week or two more because of the swelling. In applying the Bond splint, do not pull the hand too much up on the block, or the fracture will unite with a projection upon the flexor surface of the extremity and the tendons of the wrist will be apt to be caught in the callus. If a stiff joint and limited tendon-motion eventuate from the fracture, use massage, frictions, sorbefacient ointments, tincture of iodine, electricity, and hot and cold douches, or give ether and forcibly break up adhesions. Some surgeons dress Colles's fracture with a band of adhesive plaster around the wrist and support the extremity in a sling (Pilcher).

Fracture of both the Radius and Ulna near the Wrist.—Colles's fracture may be complicated by a fracture of the ulna other than of its styloid process.

Symptoms.—In fracture of the radius and ulna near the wrist the lower ends of the upper fragments come together, the upper fragment of the radius is pronated, and the lower fragment of the radius is drawn up. Pain, crepitus, mobility, shortening, and loss of function exist.

Treatment.—A fracture of the radius and ulna requires the use of the Bond splint, as for Colles's fracture.

Separation of the Lower Radial Epiphysis.—This accident occurs in children from falling upon the palm of the hand. It never happens after the twentieth year.

Symptoms.—In separation of the lower radial epiphysis the lower fragment mounts upon the upper and produces a dorsal projection like Colles's fracture, but the hand does not deviate to the radial side. The deformity resembles that of a backward carpal dislocation, but is differentiated from dislocation by the unaltered relation in the fracture between the styloid processes and the carpal bones.

Treatment.—The treatment in separation of the lower radial epiphysis consists of the use of a Bond splint, as in Colles's fracture.

Fractures of the carpus are not frequent, and they are usually compound. The *cause* is violent direct force.

Symptoms.—Fractures of the carpus are indicated by pain, swelling, evidences of direct force, sometimes crepitus, loss of power in the hand, and a very little displacement.

Treatment.—Many compound comminuted fractures of the carpus require amputation. In an ordinary compound fracture, asepticize, drain, dress with antiseptic gauze and a plaster-of-Paris bandage, cutting trap-doors in the plaster over the ends of the drainage-tube. In a simple fracture, use lead-water and laudanum for a few days. Dress the hand upon a well-padded straight palmar splint (Pl. 7, Fig. 10) reaching from beyond the fingers to the middle of the forearm, and place the hand and forearm in a sling. The splint is worn for four weeks, and passive motion of the wrist is begun in the second week.

Fracture of the Metacarpal Bones.—Metacarpal fracture is very common. One or more bones may be broken. The first metacarpal bone is oftenest broken; the third is rarely broken (Hulke). The *cause* is direct or indirect force.

Symptoms.—The signs of a metacarpal fracture are—dorsal projection of the upper end of the lower fragment, the head of the bone being felt in the palm; pain; crepitus; and often evidences of direct violence.

Treatment.—To treat a fracture of the metacarpal bones, reduce by extension; place a large ball of oakum, cotton, or lint in the palm to maintain the natural rotundity, and apply a straight palmar splint like that used in fractures of the carpus (Pl. 7, Fig. 10). It may be necessary to apply a compress over the dorsal projection. The duration of treatment is three weeks, and passive motion is begun after two weeks.

Fractures of the Phalanges.—The phalanges are often broken. The fracture may be compound. The *cause* usually is direct force.

Symptoms.—Fracture of the phalanges is indicated by pain, bruising, crepitus, and mobility, with very little or no displacement.

Treatment.—If the middle or distal phalanx is broken, mould on a trough-like splint of gutta-percha or of pasteboard, which splint need not run into the palm. If the proximal phalanx is broken, run the splint into the palm of the hand. Make the splint of gutta-percha, pasteboard, wood, or leather. The splint is worn three weeks. A sling must be worn, otherwise the finger will constantly be knocked and hurt. Some cases require a dorsal as well as a palmar splint.

Fracture of the femur is a very common injury. The divisions of the femur are (1) the upper extremity; (2) the shaft; and (3) the lower extremity.

1. **Fractures of the upper extremity of the femur** are divided into (*a*) intracapsular; (*b*) extracapsular; (*c*) of the great trochanter; and (*d*) epiphyseal separation (either of great trochanter or head).

Intracapsular Fracture of the Femur.—This fracture of the neck is transverse or only slightly oblique, and is not unusually impacted. The *cause* is slight indirect force, of the nature of a twist, acting upon a person of advanced years (more often a woman than a man). A fall upon the knees, a trip, or an attempt to prevent a fall may produce this fracture. Intracapsular fracture is never caused by direct force unless it is due to gunshot violence. The aged are more liable to intracapsular fracture than the young or the middle-aged, because, first, the angle which the neck forms to the axis of the femur becomes less obtuse with advancing years, and may even form a right angle; this change is more pronounced in women than in men; secondly, the compact

tissue becomes thinned by absorption, the cancelli diminish, the spaces between them enlarge, the bony partitions of the cancellous portion are thinned or destroyed, and the cancellous structure becomes fatty and degenerated.

Symptoms.—In intracapsular fracture there is usually shortening to the extent of from half an inch to an inch. Shortening of a quarter of an inch does not count in diagnosis, for, as Hunt shows, one limb is often naturally a little shorter than the other. If the reflected portion of the capsule is not torn, the shortening is trivial in amount or is entirely absent. In some cases shortening gradually or suddenly increases some little time after the accident. This is due to separation of an impaction, tearing of the previously unlacerated capsular reflection, restoration of muscular strength after a paresis, or absorption of the head of the bone. Shortening is due chiefly to pulling up of the lower fragment by the hamstrings, the glutei, and the rectus.

Eversion exists, spoken of as "helpless eversion," though in a very few instances the patient can still invert the leg. This eversion is due to the force of gravity, the limb rolling outward because the line of gravity has moved externally. That eversion is not due to the action of the external rotator muscles, as was taught by Astley Cooper, is proved by the fact that when a fracture happens in the shaft below the insertion of these muscles the lower fragment still rotates outward. This is further demonstrated by the considerations that the internal rotators are more powerful than the external, that some patients can still invert the limb, and that eversion persists during anæsthesia.[1] In some unusual cases *inversion* attends the fracture. Besides shortening and eversion, the leg is somewhat flexed on the thigh and the thigh on the pelvis, the extremity when rolled out resting upon its outer surface.

[1] Edmund Owens: *A Manual of Anatomy.*

Loss of power is a prominent symptom: the limb can rarely be raised or inverted. Pain is trivial except upon motion, when it can be localized in the joint. Crepitus often cannot be found, either because the fragments cannot be approximated or because they are greatly softened by fatty change. To obtain crepitus the front of the joint must be examined while the limb is extended and rotated inward. But why try to obtain crepitus? The diagnosis is readily made without it, in many cases it cannot be found, and the endeavor to obtain it inflicts pain and may effect damage. These fractures offer a not very flattering chance of repair, and efforts to find crepitus may injure the capsule or pull apart an impaction (Allis).

Altered Arc of Rotation of the Great Trochanter (Desault's sign).—The pivot on which the great trochanter revolves is no longer the acetabulum, and the great trochanter no longer describes the segment of a circle, but rotates only as the apex of the femur, which rotates around its own axis.

Relaxation of the fascia lata (Allis's sign) simply means *shortening*. The fascia lata is attached to the ilium and the tibia (ilio-tibial band), and when shortening brings the tibia nearer to the ilium this band relaxes and permits one to push more deeply inward on the injured side, between the great trochanter and the iliac crest, than on the sound side.

Ascent of the Great Trochanter above Nélaton's Line.—This line is taken from the anterior superior iliac spine to the most prominent part of the ischial tuberosity (Fig. 51). In health the great trochanter is below, and in intracapsular fracture it is above, this line.

Ascent of the Trochanter into Bryant's Triangle (Fig. 51). —Place the patient recumbent, carry a line around the body on a level with the anterior superior spines, lay down Nélaton's line, and measure the base of the triangle from the

great trochanter to the perpendicular line from the spine to determine the amount of ascent.

Morris's measurement shows the extent of inward displacement. Measure from the median line of the body to a perpendicular line drawn through the trochanter on each side of the body.

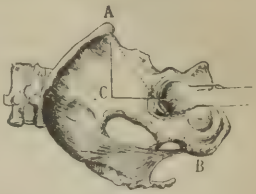


FIG. 51.—A C D, Bryant's Ilio-femoral Triangle; A B, Nélaton's Line (Owen).

Diagnosis.—Intracapsular fracture without separation of the fragments may be mistaken for a mere contusion, and the diagnosis may continue obscure unless the fragments separate. Loss of function in contusion is rarely complete or prolonged, although occasionally the head of the bone is absorbed. Intracapsular fracture may be confused with *extracapsular* fracture or with a dislocation of the hip-joint. Extracapsular fracture, which is commonest in young adults, results from direct violence over the great trochanter; if non-impacted, there are noted shortening of from one and a half to over three inches, crepitus over the great trochanter, and usually, but not invariably, eversion; if impacted, there is less eversion, crepitus is almost or entirely absent, and the shortening is limited to about an inch. Great tenderness exists over the great trochanter in both impacted and non-impacted fractures. In dislocation on the dorsum of the ilium the patient is usually a strong young adult. There are inversion (the ball of the great toe resting on the instep of the sound foot), rigidity, ascent of the bone above Nélaton's line, and shortening of from one to three inches. In dislocation into the thyroid notch there is possibly eversion, but it is linked with lengthening.

Prognosis.—The prognosis is not very favorable. Old people not unusually die. In impacted fracture bony union may occur; in non-impacted fracture fibrous union is the best

that can be expected. Non-union is not unusual. Permanent shortening to some degree is inevitable, and the function of the joint is sure to be more or less impaired. It will be found necessary in many cases for the patient to always employ support in walking.

Treatment.—In treating a very old or a feeble person for intracapsular fracture, make no attempt to obtain union. Keep the patient in bed for two weeks, give lateral support by sand-bags, tie around the ankle a fillet, to which attach a weight of a few pounds, and hang the weight over the foot-board of the bed. When pain and tenderness abate, order the patient to get into a reclining chair, and permit him very soon to get about on crutches. If hypostatic congestion of the lungs sets in, if bed-sores appear, if the appetite and digestion utterly fail, or if diarrhœa persists, abandon attempts at cure in any case and secure for the sufferer sunshine and fresh air. Immobilize the fracture as thoroughly as possible by means of pasteboard splints. If it is determined to treat the case, combine extension with lateral support by means of sand-bags and the extension apparatus originally devised by Gurdon Buck. Place the subject on a firm mattress, and if the patient be a man, shave the leg. Cut a foot-piece out of a cigar-box, perforate it for a cord, wrap it with adhesive plaster as shown on Plate 7, Figures 15, 16, run the weight-cord through the opening in the wood, and fasten a piece of plaster on each side of the leg, from just below the seat of fracture to above the malleolus (Pl. 7, Fig. 14). The plaster is guarded from sticking to the malleoli by having another piece stuck to it at each of these points. Apply an ascending spiral reverse bandage over the plaster to the groin (Fig. 52), and finish the bandage by a spica of the groin. Slightly abduct the extremity. Put a brick under each leg of the bed at its foot, thus obtaining counter-extension by the weight of the body.

Run a cord over a pulley at the foot of the bed, and get extension by the use of weights. From ten to fifteen pounds will probably be necessary at first, but after a day or two from six to eight pounds will be found sufficient (remember that a brick weighs about five pounds). Make a bird's-nest pad of oakum for the heel. Take two canvas bags, one long

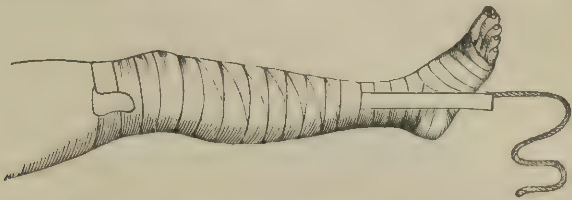


FIG. 52.—Adhesive Plaster Applied to Extension.

enough to reach from the crest of the ilium to the malleolus, the other long enough to reach from the perineum to the malleolus. Fill the bags three-quarters full of dry sand, sew up their ends, cover the bags with slips, and put the bags in place in order to correct eversion. The slips may be changed every third or fourth day. The bowels are to be emptied and the urine is to be voided into a bed-pan, unless using a fracture-bed. Maintain extension for five or six weeks, then mould pasteboard splints upon the part, and keep the patient in bed for three or four weeks more. In from eight to ten weeks after the accident the patient may get about on crutches. Union, if it takes place, is cartilaginous, and not bony, and there is bound to be some shortening and some stiffness of the joint. Passive motion is not made until after eight weeks have elapsed. Professor Senn claims that by his method of "immediate reduction and permanent fixation" bony union is obtained in fractures of the neck of the femur within the capsule. He "places the patient in the erect position, causing him to stand with his sound leg upon a stool or a box about two feet in height;

in this position he is supported by a person on each side until the dressing has been applied and the plaster has set.

"Another person takes care of the fractured limb, which in impacted fractures is gently supported and immovably held until permanent fixation has been secured by the dressing. In non-impacted fractures the weight of the fractured limb makes auto-extension, which is often quite sufficient to restore the normal length of the limb; if this is not the case, the person who has charge of the limb makes traction until all shortening has been overcome as far as possible, at the same time holding the limb in position, so that the great toe is on a straight line with the inner margin of the patella and the anterior superior spinous process of the ilium. In applying the plaster-of-Paris bandage over the seat of fracture a fenestrum, corresponding in size to the dimensions of the compress with which the lateral pressure is to be made, is left open over the great trochanter.

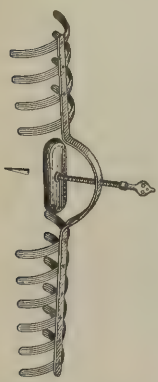


Fig. 53.—Senn's Apparatus (Senn).

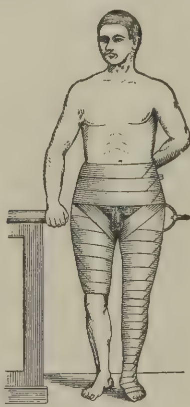


Fig. 54.—Senn's Apparatus Applied (Senn).

"To secure perfect immobility at the seat of fractures, it is not only necessary to include in the dressing the fractured limb and the entire pelvis, but it is absolutely necessary to also include the opposite limb as far as the knee and to extend the dressing as far as the cartilage of the eighth rib.

"The splint (Fig. 53) is incorporated in the plaster-of-Paris dressing, and it must carefully be applied, so that the compress, composed of a well-cushioned pad with a stiff, unyield-

ing back, rests directly upon the trochanter major, and the pressure, which is made by a set-screw, is directed in the axis of the femoral neck. Lateral pressure is not applied until the plaster has completely set. Syncope should be guarded against by the administration of stimulants.

"As soon as the plaster has sufficiently hardened to retain the limb in proper position, the patient should be laid upon a smooth, even mattress, without pillows under the head, and in non-impacted fractures the foot is held in a straight position and extension is kept up until lateral pressure can be applied.

"No matter how snugly a plaster-of-Paris dressing is applied, as the result of shrinkage it becomes loose, and without some means of making lateral pressure it would become necessary to change it from time to time in order to render it efficient. But by incorporating a splint in the plaster dressing (Fig. 54) this is obviated, and the lateral pressure is regulated, day by day, by moving the screw, the proximal end of which rests on an oval depression in the centre of the pad."

Extracapsular Fracture.—The line of extracapsular fracture is at the junction of the neck with the great trochanter, and is partly within and partly without the capsule, the fracture being generally comminuted and often impacted. The *cause* is violent direct force over the great trochanter (as by falling upon the side of the hip). This fracture is most usual in strong young adults.

Symptoms.—When impaction is absent there is marked crepitus, which is manifested most when the fingers are put over the great trochanter; there are great pain, swelling, and ecchymosis; there is absolute inability on the part of the patient to move the limb, and passive movements cause great pain; there is shortening to the extent of at least one and a half inches, and often three inches; and there is abso-

lute eversion with slight flexion both of the leg and the thigh. All these symptoms follow violent direct lateral force. In the *impacted* form of extracapsular fracture, in addition to the aid given the surgeon by the history, there is severe pain which is intensified by movement or pressure; shortening exists to the extent of one inch at least, which is not corrected by extension; there is also great loss of function; and whereas the limb may be straight or even inverted, it is usually everted. Crepitus cannot be obtained without improper violence, and the trochanter moves in a large arc of rotation, although it is in Bryant's triangle and above Nélaton's line.

Treatment.—In treating extracapsular fracture, make extension, raise the foot of the bed, and apply the extension apparatus with sand-bags for four weeks; then apply a plaster dressing and get the patient up on crutches. Remove the plaster at the end of four weeks. In impacted fracture use a moderate force in extending, but never violently pull the bones apart.

Fracture of the Great Trochanter.—This process may be (1) broken off without any other injury, but in most cases (2) the line of fracture runs through the trochanter, and leaves one portion of the trochanter attached to the head and neck and the other part attached to the shaft. The *cause* is violent direct force over the great trochanter.

Symptoms and Treatment.—The symptoms of the second form are similar to those of extracapsular fracture. On rotating the femur the lower part of the trochanter moves with it, but not the upper. The lower fragment goes upward and backward and projects by the side of the sciatic notch. There are shortening, eversion, crepitus, and altered position of the trochanter. The symptoms of the first form resemble those of epiphyseal separation. The *treatment* of the second form is like that in extracapsular fracture, and the first

form is treated like separation of the epiphysis of the trochanter.

Separation of the upper epiphysis of the femoral head is a very rare result of accident; it occurs most often from disease and in youth.

Symptoms and Treatment.—The symptoms are like those of fracture of the neck, except that the crepitus is soft. The *treatment* is extension as above directed.

Separation of the epiphysis of the great trochanter is a very rare accident. The *cause* is direct violence, and the injury occurs only in youth.

Symptoms.—The trochanter is found to have ascended and passed posteriorly; there is no shortening; all the motions of the hip-joint can be obtained; if the thigh is flexed, abducted, and rotated externally, and the fragment pushed down and forward, crepitus is obtained—soft in epiphyseal separation, hard in fracture.

Treatment.—In treating separation of the epiphysis of the great trochanter, flex the leg on the thigh and the thigh on the pelvis, place the extremity upon its outer surface, keep it fixed by some form of retentive apparatus, and try to draw the trochanter downward and forward by adhesive strips or by a pad and bandage. Some degree of lameness is inevitable, even after Bryant's extension. Bryant's extension directly upward may admit of the trochanter being pulled downward upon the bone. Dressing must be applied for six weeks, and crutches and pasteboard splints are used for four weeks more.

2. **Fractures of the shaft of the femur** may affect any portion of the shaft, but especially the middle third, and may occur at any age. The *cause* of fractures in the upper third is usually indirect force; fractures in the lower third are due to direct force; and in fractures of the middle third these two causes are about equally potential. Fracture from muscular

action occasionally occurs. Oblique fracture is the usual variety.

Symptoms.—The chief symptom in fracture of the shaft of the femur is great displacement, except when impaction occurs or when the break is in a child and the periosteum is untorn. As a rule, the lower fragment is drawn up and is posterior and somewhat to the inside of the upper fragment, and undergoes external rotation (the drawing up is due to the rectus and hamstrings; the passing in is due to the adductor muscles; the rotation outward arises from the weight of the limb). In fracture of the upper third the upper fragment is apt to be thrown strongly forward and outward. Some attribute this to the action of the psoas, iliacus, and external rotator muscles, but Dr. Allis thinks it is due to the lower fragment pushing the upper fragment into this position. There is complete loss of function, the thigh and leg being semiflexed and everted. There are shortening to the extent of two or three inches, pain on movement, preternatural mobility, crepitus, and obvious deformity, and the ends of the fragments can be felt. In impaction there is shortening with altered axis of the limb.

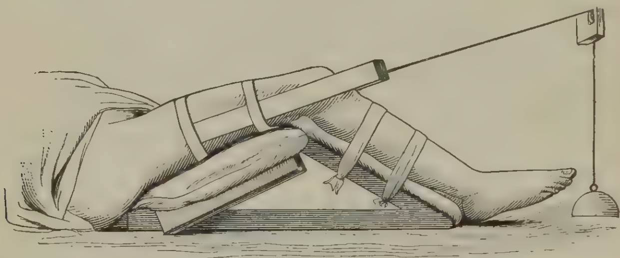


FIG. 55.—Dressing of Fracture of the Femur in the Upper Third with Extension upon a Double Inclined Plane (Agnew).

Treatment.—In fractures of the shaft of the femur some amount of permanent shortening is almost inevitable. In fractures of the upper third, use Agnew's plan—namely, a double

inclined plane with extension in the axis of the partly-flexed thigh (Fig. 55). If, notwithstanding position and extension, the upper fragment projects, push it into place and bind short splints upon the limb. Extension is continued for four weeks, a plaster-of-Paris bandage being used for four weeks more, the patient being then allowed to get about on crutches. Some surgeons, in fractures of the upper third, apply a plaster-of-Paris bandage to the leg, thigh, and pelvis, extension being made from the foot while the dressing is being applied. The anterior splint of Nathan R. Smith is much used in the South in treating fractures of the shaft and the upper extremity (Fig. 56). In fractures of the middle third and upper part of the lower third of the shaft, use the extension apparatus (Pl. 7, Fig. 14) with the sand-bags, running the plaster to just below the seat of the fracture, and the roller bandage to a little above this point. Extension is to be continued for four weeks, and the plaster-of-Paris bandage is used for four weeks more. In fractures of the lower part of the lower third of the shaft, use a double inclined plane (Pl. 7, Fig. 2) alone. A McIntyre splint (Fig. 57) is a useful form of double inclined plane. At the end of four weeks apply plaster, which is to be worn for four weeks.

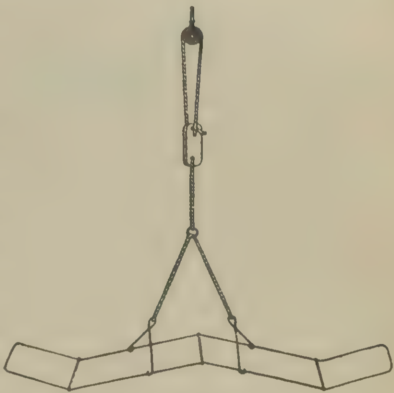


FIG 56.—Smith Anterior Splint.

Fracture just above the Condyles.—The *line* of this fracture is well above the epiphyseal line. The femoral artery is in danger from the fragments. The *cause*, as a rule, is direct violence. Indirect force is sometimes re-

sponsible (falls upon the feet). The knee-joint may be opened.

Symptoms.—The upper end of the lower fragment passes back into the popliteal space and is drawn upward (rectus, hamstrings, gastrocnemius, and popliteus), the upper fragment passes inward, and the deformity is very manifest. There are shortening, crepitus, and mobility. The ends of the fragments can be felt. If the force has been very great, a T-fracture results, and in this the knee is broadened and crepitus is got by moving the condyles, one up and the other down.

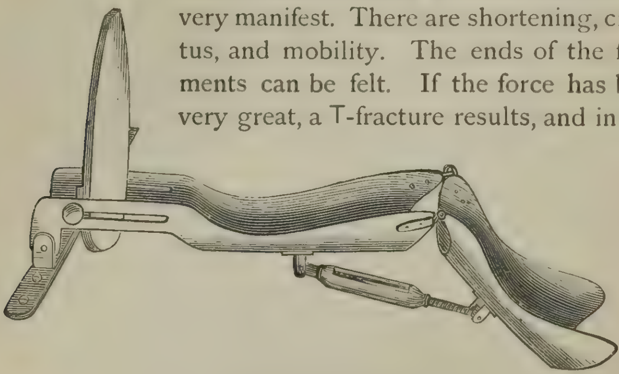


FIG. 57.—McIntyre Splint (Tiemann).

Treatment.—In treating a fracture above the condyles, place the limb on a double inclined plane for five weeks, then start passive motion once every other day, restoring the limb to the splint after the movements are completed. At the end of eight weeks after the accident, remove the dressings, and, if the knee-joint be stiff, use for some time massage, motions, hot and cold douches, ichthyol inunctions, etc. Bryant treats this fracture in extension, cutting the tendo Achillis, if necessary, to amend deformity.

Fracture Separating Either Condyle.—The *cause* of this fracture is direct force.

Symptoms and Treatment.—The broken piece is drawn upward, the leg bends toward the injury, crepitus exists, the

knee is much broadened, there is no shortening, and considerable swelling is sure to arise. In treating a fracture separating either condyle, use a double inclined plane as directed above.

Longitudinal fractures run up from the knee-joint. The *cause* is a fall upon the feet or the knees.

Symptoms and Treatment.—The symptoms of longitudinal fracture are often obscure. The femur is broadened when the knee is flexed. The split is detected between the condyles. The *treatment* is the straight position in plaster for eight weeks.

Separation of the lower epiphysis occurs only before the twenty-first year.

Symptoms.—The symptoms in separation of the lower epiphysis are like those of fracture, but crepitus is moist. The danger is that the growth of bone will be stunted.

Treatment.—The treatment for separation of the lower epiphysis is a double inclined plane as above directed.

Fracture of the patella is a very common accident. The *cause* is direct force (producing vertical, star-shaped, or oblique lines of fracture) or muscular action (producing a transverse line of fracture).

Fractures of the Patella by Muscular Action.—The knee-cap is more often broken by muscular action than is any other bone. When the knee is partly flexed the middle third of the patella rests upon the condyles of the femur and the upper third of the knee-cap projects above them; when in this position a contraction of the quadriceps may easily cause a fracture near the centre of the bone (Fig. 58). Both patellæ may be broken at once. In this form of fracture the joint, and often the prepatellar bursa, is opened.

FIG. 58.—Fracture of the Patella by Muscular Action (Treves).

Symptoms.—The symptoms in fractures by muscular action are—rapid and enormous swelling, due to the effusion first of

blood and then of synovia and inflammatory products into and around the joint; absolute inability to raise the limb from the bed. The fragments are widely separated, this separation being distinctly manifest to the touch unless swelling is great. The separation is accentuated by flexion of the leg. Crepitus is detected if the upper fragment can be pushed down until it touches the lower piece, but if swelling is great this cannot be done. Union, if it occurs, will be ligamentous, and not bony, and if the patient gets about too soon, apparently well-united fragments will by degrees stretch far asunder.

Transverse Fractures of the Patella.—*Treatment.*—If the swelling in transverse fracture of the patella be so great as to prevent approximation of the fragments, reduce it by bandaging for a day or two, by using ice-bags and lead-water and laudanum, or by aspirating the joint. When the swelling diminishes, bring the two fragments into apposition, pull them together by adhesive plaster, and put on a well-padded posterior splint. Run a piece of adhesive plaster over the upper end of the upper fragment, draw the bone down, and fasten the plaster behind and below the joint. Run another piece of plaster over the lower end of the lower fragment, draw the bone up, and fasten the plaster behind and above the joint. A third piece is run over the junction of the fragments to prevent tilting. Agnew's splint admirably accomplishes this approximation (Pl. 7, Figs. 11, 12). A bandage holds the splint in place, and may be carried around the knee by figure-of-8 turns. The heel is sometimes raised upon a pillow so as to extend the leg and to semiflex the thigh, but this is not essential. Remove and reapply the dressing every few days, as it inevitably becomes loose. At the end of three weeks remove the splint permanently and apply a plaster-of-Paris dressing from just above the ankle to the middle of the thigh. The dressing is to be worn

for five weeks. At the end of eight weeks let the patient walk with canes, the joint being kept fixed for four weeks more by pasteboard splints or by a light plaster-of-Paris bandage. For one year after removing the splints and plaster a lacing knee-cap and a posterior splint should be worn to support the joint. The plan of prolonged retention renders more or less joint-stiffness a certain occurrence, but this is less of an impediment than the wide separation of the fragments that inevitably attends an early use of the joint.

Malgaigne's hooks (Fig. 59), if employed to treat these fractures, are to be inserted with the full antiseptic care of an ordinary surgical operation. Insert the lower hooks just below the point of the patella, entering them under its edge, press the fragments together, draw up the skin over the upper fragment to prevent puckering, and insert the upper hooks with force just above the upper fragment, letting the points of the hooks bear upon the bone. Lock or screw the hooks together, dress with antiseptic gauze, and apply a posterior splint. Remove the hooks in three weeks, and treat with plaster as in the preceding case when the special splint was removed.

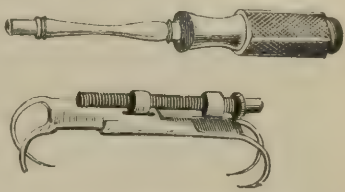


FIG. 59.—Malgaigne's Hooks.

Among other plans of treatment may be mentioned wiring the fragments (see *Operations upon Bones*); encircling the fragments with a subcutaneous silk ligature; passing a pin through the tendon of the quadriceps, another through the ligament of the patella, and approximating the two by figure-of-8 turns with a silk cord, thus drawing together the fragments.

Fractures of the patella by direct force are vertical, stellate, oblique, or V-shaped, and are often incomplete.

Symptoms.—Fractures of the patella by direct force are indicated by discoloration, swelling, great difficulty in movement, and much pain. There may or may not be crepitus, and rarely is there separation of the fragments. Bony union occurs in these fractures.

Treatment.—Fracture by direct force requires a posterior splint, the local use of lead-water and laudanum, and the application of a bandage. If there is any separation, approximate the fragments by bandages and compresses. The danger in these cases is not non-union, but is ankylosis; hence, begin passive motion of the knee-joint in the fourth week after the accident. Remove the dressings at the end of six weeks, and let the patient at once get about.

Fractures of the Leg.—In leg-fractures both bones or only one bone may be broken.

Fractures of the tibia are divided into (1) fractures of the upper end; (2) separation of the upper epiphysis; (3) fractures of the shaft; (4) fractures of the lower end; and (5) separation of the lower epiphysis.

Fractures of the upper end of the tibia are uncommon. They may be transverse, oblique, or vertical running into the joint. The *cause* is direct violence.

Symptoms.—In fracture of the upper end of the tibia there is contusion of the soft parts. In a *transverse* fracture there are mobility and crepitus, but there is little displacement. In *oblique* fracture crepitus and mobility are marked and the axis of the limb is altered. In *vertical* fractures entering the joint there is great swelling of the knee-joint. In *comminuted* fractures, which exhibit marked signs, union is readily obtained, but if the joint has been damaged stiffness is sure to ensue.

Treatment.—In treating fractures of the upper end of the tibia, employ a double inclined plane in the form of a McIntyre splint (Fig. 57) or in the form of a fracture-box

(Pl. 7, Fig. 1). Lead-water and laudanum and cold are applied about the knee-joint. At the end of the fourth week begin passive motion, reapplying the splint after each daily séance. In six weeks let the patient get about, first with crutches, then with a cane, then without any artificial support.

Separation of the Upper Epiphysis of the Tibia.—There is only one recorded case (Pick).

Fractures of the Shaft of the Tibia.—The *cause* of these fractures is direct force. The fracture is generally transverse in the upper part of the bone and oblique in the lower part (Pickering Pick).

Symptoms.—In transverse fracture of the shaft of the tibia there is no deformity, and the support of the fibula may even permit of walking; there is fixed pain; there may or may not be inequality of fragments felt by the finger; and there are crepitus, mobility, and often linear ecchymosis. In oblique fractures there usually exist crepitus, a little mobility, and some deformity. The deformity depends on the direction of the line of fracture, and, as this line is usually from above downward, inward, and a little forward, the lower fragment usually passes behind the upper fragment and rotates inward.

Treatment.—In treating fractures of the shaft of the tibia, if there be much swelling, put the limb in a fracture-box (Pl. 7, Fig. 1; Pl. 8, Fig. 6) and apply lead-water and laudanum. A silicate-of-soda or a plaster-of-Paris dressing is applied when the swelling subsides, or the dressing is used at once if swelling is slight. The patient gets about on crutches. The dressing is removed in six weeks, and the patient goes about for one week on crutches, lightly using the foot, and then for one week with a cane. At the end of eight weeks the leg may be used, but not too much at first.

Fractures of the Lower End of the Tibia: Fracture of the Inner Malleolus.—The *cause* of fracture of the inner malleolus is direct force.

Symptoms and Treatment.—The symptoms of fracture of the inner malleolus are some downward displacement, depression above the fragment, mobility, and crepitus. The *treatment* is to push the fragment into place and use side-splints or a fracture-box for two weeks, when a plaster-of-Paris or a silicate dressing may be substituted and the patient be ordered to use crutches. Remove the plaster four weeks after it is applied, and direct the patient to gradually bear his weight upon the leg, as outlined above.

Separation of the lower epiphysis of the tibia is a very rare accident. The *treatment* is a fixed dressing for six weeks.

Fracture of the fibula alone is commoner by far than is fracture of the tibia alone. Fractures in the upper two-thirds, which are rare, are usually due to direct force. Fractures in the lower third are frequent, and they arise from indirect force.

Fractures of the Upper Two-thirds of the Fibula.—In these fractures the *cause* is direct force.

Symptoms.—In fracture of the upper two-thirds of the fibula the patient can often walk. The bone is deeply situated, and displacement cannot often be made out. There is a fixed pain which is intensified by movement and by pressure. Pressure upon the lower fragment does not move the upper fragment. Crepitus is sometimes felt, and a linear ecchymosis is apt to appear. The bone bends normally, hence slight mobility is of no value diagnostically.

Treatment.—In treating a fracture of the upper two-thirds of the fibula, apply a plaster-of-Paris or a silicate bandage and direct that it be worn for six weeks. Weight is not to be put upon the foot for eight weeks after the accident.

Fractures of the Lower Third of the Fibula.—In these fractures the *cause* is indirect force, especially twists of the foot. Forcible inversion of the foot pulls upon the external lateral ligament and the external malleolus, forces the fibula

outward, and tends to break it, the lower fragment being displaced outward. Forcible eversion pulls the internal lateral ligament off from the inner malleolus (often breaks the malleolus) and fractures the fibula above the ankle, the bone being displaced inward.

Symptoms.—In the lower third of the fibula the bone is superficial, and the irregularity of a fracture is manifest to the touch. There is localized pain which is increased by pressure or by motion. Crepitus may exist. Deformity is often exhibited by the position of the foot.

Pott's fracture, which is a fracture of the lower fifth of the fibula accompanied by outward dislocation of the foot, is due to powerful eversion of the foot. This outward dislocation is rendered possible by rupture of the deltoid ligament or—what is far commoner—by the tearing off of a portion of the internal malleolus.

Treatment.—In fractures of the lower third of the fibula, after reducing displacement, place the limb in a fracture-box containing a soft pillow. A bird's-nest pad of cotton or oakum is made for the heel (Pl. 8, Fig. 6). A fillet around the ankle fastens the foot to the foot-piece of the box; a pad of oakum rests between the foot-piece and the sole. If dressing Pott's fracture, put a compress above the inner malleolus and another compress below the outer malleolus. Close the sides of the box and tie them together with a bandage. Swing the box, if desired, on a gallows. Every day let down the sides of the box and rub the leg, the ankle, and the foot with alcohol. In ten days apply a plaster-of-Paris bandage and let the patient get about on crutches. Remove the plaster at the end of the fifth week after the accident, and let the patient go about with crutches for one week and with a cane for a week longer.

Some surgeons dress Pott's fracture with a Dupuytren splint. This is a straight splint (Pl. 7, Fig. 9) which reaches

from the head of the tibia to or below the toes. This splint is padded, and a pyramidal pad with the base down is laid upon the inner surface of the leg, above the inner malleolus, the splint being put upon the inner surface of the leg, over the pad. The splint is fastened as shown on Plate 7 (Fig. 9), and the leg is semiflexed upon the thigh and is laid upon its outer surface on a pillow. After ten days apply the plaster-of-Paris bandage, which is to be worn as above directed.

Fracture of both bones of the leg, a very common injury, is often compound, and is not unusually comminuted. Fractures by direct force, such as blows or kicks, are commonest in the upper half of the leg. Fractures by indirect force, as by falls, are commonest in the lower half of the leg. In fractures from indirect force the tibia breaks first, and then the fibula breaks at a higher level. The point of greatest liability to fracture from indirect force is the junction of the lower and middle thirds. Fractures of the leg are usually oblique, but they may be transverse if arising from direct force. Spiral, torsion, or V-shaped fractures and longitudinal breaks sometimes occur. In oblique fractures, as a rule, the line of fracture runs downward, inward, and a little forward.

Symptoms.—Fracture of both bones of the leg is easy of recognition. By running the finger along the crest of the tibia displacement will be found, except in transverse fractures, when it may not occur. The common displacement is for the lower fragment to ascend and pass behind the lower end of the upper fragment and to rotate a little outward, and for the upper fragment to project in front. This ascent is due to the action of the gastrocnemius and soleus muscles. If the line of fracture is in a direction the reverse of that which is usual, the lower fragment ascends in front of the lower end of the upper fragment. In fracture of both bones there are mobility, crepitus, pain, and inability to walk. In fractures from direct force there is more or less damage

to the soft parts. A fracture near the ankle is distinguished from a dislocation by the fact that the deformity is easily reduced, but it tends to recur in the fracture, and, further, that in a fracture the relations of the malleoli to the tarsus are unaltered.

Treatment.—In treating a simple fracture, reduce by extension and counter-extension, and use a fracture-box (Pl. 7, Fig. 1) as in Pott's fracture (p. 391), though the compresses are not required. If the soft parts are bruised, use lead-water and laudanum; if they are lacerated, apply antiseptic dressings. The fracture-box may be swung upon a gallows. After three weeks apply plaster-of-Paris or silicate-of-soda dressing and let the patient sit up in a chair daily for one week; at the end of this time the patient may get about with crutches. At the end of six weeks after the accident, remove the plaster, and let the sufferer get about with crutches for two weeks and with a cane for two weeks more. Dr. Brinton dresses a fracture of both bones of the leg for two weeks in a fracture-box, for two weeks in side-splints, and for two weeks in an immovable dressing. If the fracture is compound, asepticize thoroughly, make a counter-opening, insert a drainage-tube, dress with bichloride gauze, apply a plaster bandage, and cut trap-doors over the openings of the tube (see Fig. 47). Remove the tube, as a rule, in about forty-eight hours; but the patient's temperature is a better guide than time.

Fractures of the bones of the foot are rather rare accidents. Owing to the number of the bones and to the elasticity of their connections, the force of blows and falls is spread and dissipated. Fractures from direct force are often compound. The *cause* of fracture of either the scaphoid, the cuboid, or any of the cuneiform bones is direct force. Fractures of the os calcis and astragalus arise, as a rule, from indirect force, such as falls, but the calcaneum

may be broken by direct violence. In rare instances the os calcis has been broken by contraction of the great calf-muscles.

Symptoms.—In fracture of the os calcis there are severe pain, swelling, crepitus, mobility, often an apparent widening of the bone, not unusually a loss of the arch of the foot (Pick). In some cases the posterior fragment is drawn up by the calf-muscles, and in other cases there is deformity. In fracture of the astragalus displacement may occur which resembles that of a dislocation. Crepitus may or may not be detected. If crepitus cannot be found, it is not certain that a fracture is present, though the patient may be unable to stand and there may be swelling and pain on pressure. Fractures of the other bones are hard to detect. There may or may not be crepitus, which, if it exists, is hard to localize; there are pain on standing and on pressure and bruising of the soft parts.

Treatment.—To treat a fracture of the os calcis when no deformity exists, use a fracture-box for two weeks; maintain the foot at a right angle to the leg; apply lead-water and laudanum; then put on an immovable dressing, and let it be worn for four weeks. In fracture of the os calcis with drawing up of the posterior fragment, flex the leg upon the thigh, extend the foot, and maintain this position by means of a band around the thigh, the band being fastened by means of a cord to a slipper (Pl. 9, Fig. 5), the leg resting upon its outer side. At the end of two weeks apply plaster, and let it be worn for four weeks. If the projecting fragment of the os calcis cannot be forced into place, and if it makes dangerous pressure upon the skin, excise it; if it does not make pressure which threatens sloughing, place the joint in a position favorable for ankylosis, and immobilize. In a fracture of the astragalus, use a fracture-box and then an immovable dressing, as in fracture of the os calcis without

deformity. Fractures of the other bones of the tarsus are almost invariably compound, and the injury may require drainage and immovable dressing, excision, or even amputation.

Fractures of the metatarsal bones are due to direct force and are almost always compound. Fractures from crushes usually demand excision or amputation. When only one bone is broken displacement is slight, there is severe pain on motion and pressure, and crepitus can generally be obtained. A simple fracture of a metatarsal bone is dressed in a fracture-box for one week and in immovable dressings for three weeks.

Fractures of the phalanges of the toes are due to direct force and are often compound. They may require immediate amputation.

Treatment.—In a compound fracture where amputation is unnecessary, drain with strands of catgut for forty-eight hours and dress antiseptically; at the end of this time apply over the bichloride gauze a gutta-percha or a pasteboard splint extending from beyond the end of the toe to well up upon the sole of the foot, and fix the splint in place with a spiral bandage of the toe and instep. The splint is to be worn for four weeks. In a simple fracture, use a splint of gutta-percha, pasteboard, or binder's board, and let it be worn for three weeks.

3. Diseases of the Joints.

Synovitis is an inflammation of the synovial membrane alone. If other structures besides the synovial membrane are involved, the condition is known as "arthritis." Most cases of acute joint-inflammation begin as synovitis. Two forms of synovitis exist—namely, *acute* and *chronic*.

Acute Synovitis.—The *causes* of acute synovitis are contusions, sprains, twists, exposure to cold or damp, wounds,

infection, and rheumatism. The membrane is red and swollen and the joint contains an excess of turbid fibrinous fluid. If the inflammation advances, arthritis arises and sometimes blood is effused.

Symptoms.—The symptoms of acute synovitis are—pain, which is increased by motion of the joint, by pressure upon the articulation, and by a dependent position of the limb, and which is worse at night; a fluctuating swelling is noted, most marked between the ligaments, which swelling bulges out the synovial area and hides or obscures the articular heads of the bones (the patella floats up above the condyles); the skin over the joint is not reddened, but feels hot to the hand of the observer; the joint is partly flexed; fever exists, varying in degree with the size of the joint, the acuteness of the attack, and the nature of the cause. In septic cases rigors occur, there is a septic temperature, and the joint soon gives evidence of containing pus (periarticular œdema). Traumatic synovitis without infection tends toward cure without suppuration if the patient is healthy, and ankylosis is rare. Rheumatic synovitis proceeds to arthritis.

Treatment.—In treating acute synovitis, immobilize the joint in the position of rest (semiflexion), apply leeches, use the ice-bag or the Leiter coil, and follow the cold by lead-water and laudanum. After a day or two apply gentle pressure, intermittent heat, and iodine and ichthyol. If the effusion is very great and persistent, and pressure, astringents, and sorbefacients fail, aspirate with antiseptic care. If effusion recurs, apply a plaster-of Paris dressing or use flying blisters and massage.

Chronic Synovitis.—Chronic synovitis follows acute synovitis or it may be chronic from the start. The synovial membrane looks nearly natural, but is œdematous, and the joint contains an excess of fluid. If the quantity of fluid is large, the patella floats up and the disease is called

"hydrops articuli" or "dropsy." In prolonged cases the synovial membrane is thickened in some places, softened in others, and is often adherent, and the villous processes of the synovial membrane are hypertrophied. If the membrane becomes extensively softened (pulpy degeneration), the softened areas bulge and suppuration eventually occurs.

Symptoms.—In chronic synovitis pain is absent or is only present through exercise or from pressure, and is slight even then; there is some limitation of movement; passive motion may develop creaking or crepitus; fluctuation is apparent; there is atrophy in the muscles about the joint; and the hypodermatic needle will draw out a viscid, straw-colored or bloody fluid.

Treatment.—For hydrops use rest and pressure (a Martin rubber bandage or, better, a plaster dressing), massage, douches, frictions, passive movements, and flying blisters. Painting the joint with iodine and spreading over it blue ointment, and inunctions with ichthyol, may do good. The actual cautery is a valuable expedient. Aspiration and the subsequent use of a plaster-of-Paris bandage may be tried in some cases. Many surgeons advise aspiration, washing out with boiled water, injecting a 5 per cent. solution of carbolic acid, and immobilizing. Incision and drainage is a radical but proper plan. If pulpy degeneration exists, perform an excision or an erasion. If pus forms, incise at once and drain. Internally, treat any existing diathesis and give good food, tonics, and stimulants.

Arthritis.—By this term is meant not only inflammation of a synovial membrane, but also of other structures composing and surrounding a joint. It may follow a traumatic synovitis; it may be due to pus cocci, to tubercle bacilli, to infectious diseases (gonorrhœa and typhoid fever), to rheumatism, to gout, to syphilis, and to lesions of the spinal cord. Arthritis may be either acute or chronic.

Tubercular Arthritis (White swelling; Strumous joint; Pulpy degeneration).—*Pathology and Symptoms.*—The exciting cause of tubercular arthritis may be strains, blows, twists, or cold. The primary infection with tubercle bacilli is usually in the bone, though it may be in the synovial membrane, the joint-capsule, or the structures about the joint. If the primary infective focus is in the bone, a portion of the cartilage is destroyed and the joint is opened, or a sinus forms and perforates the synovial membrane. When tubercular inflammation attacks the synovial membrane granulation tissue is formed, and the capsule and periarticular structures soon become involved in the process; the parts thicken and soften from caseation, and they may be covered with tubercles, though but little fluid is usually effused into the joint. Some few cases present large joint-effusions. In the ordinary form of arthritis there occurs what is known as "gelatiniform degeneration;" the embryonic tissue is formed in large amount as fungous growths; the structures are markedly œdematous and softened; the relaxed ligaments yield under pressure; the natural contour of the joint is lost, and it becomes spindle-shaped; all the structures, articular and periarticular, are glued into one mass; the skin about the joint is white, thick, and adherent, and in it one or more large veins are seen; fluctuation or pseudo-fluctuation is noted when caseation has occurred; pain is not often severe, but it can usually be elicited by certain motions or by firm pressure (but the pain will always be severe when the epiphysis is involved); the temperature of the part is somewhat elevated; deformity results from destruction of bone, cartilage, and ligament, from muscular spasms, and from the habitual assumption of certain attitudes to secure relief from pain; there is soon impairment of joint-motions. When the products of a tubercular arthritis caseate, the thick liquid seeks exit by forming sinuses from which

caseous pus runs. If a sinus becomes infected with pyogenic cocci, and the joint itself becomes their prey, acute suppuration arises in the joint, and constitutional involvement is pronounced and perilous to life.

In pannous synovitis a large effusion is formed, there is but little granulation tissue, though the tubercles are present in large numbers, and the ligaments and structures about the joint are slightly or not at all implicated. The diagnosis early in a case is difficult, often impossible, and the prognosis is grave. In only a very few cases, even when recognized early, is a cure obtained without impairment of joint-function. The best that can usually be accomplished is a cure with more or less ankylosis, fibrous or bony; but often ankylosis is complete. Long after the disease is apparently cured, it may break forth anew. Tubercular lesions may arise in a distant organ, or general tuberculosis may occur. Caseation is apt to produce severe constitutional disorder. Infection by pus organisms gives rise to grave danger of septicæmia. Death is not unusual from exhaustion, from septicæmia, from disseminated tuberculosis, from tubercle in an important organ, or from amyloid disease.

Treatment.—Constitutionally, the treatment is directed against the tubercular diathesis. Locally, rest is of the first importance, and it is maintained for many weeks, it being obtained by splints, by a plaster-of-Paris bandage, or by extension appliances. Aspiration can be used for fluid accumulations. Caseous masses are often let alone, or an aspirator is used and the joint drained, washed out with boiled water, and injected with an emulsion of iodoform and glycerin (10 per cent.). Injections of balsam of Peru or of iodoform emulsion about the joint once a week are efficient in some cases. If these means fail, if the patient gets worse, or if the condition of the sufferer renders dangerous the prolonged conservative course, then operate, removing the

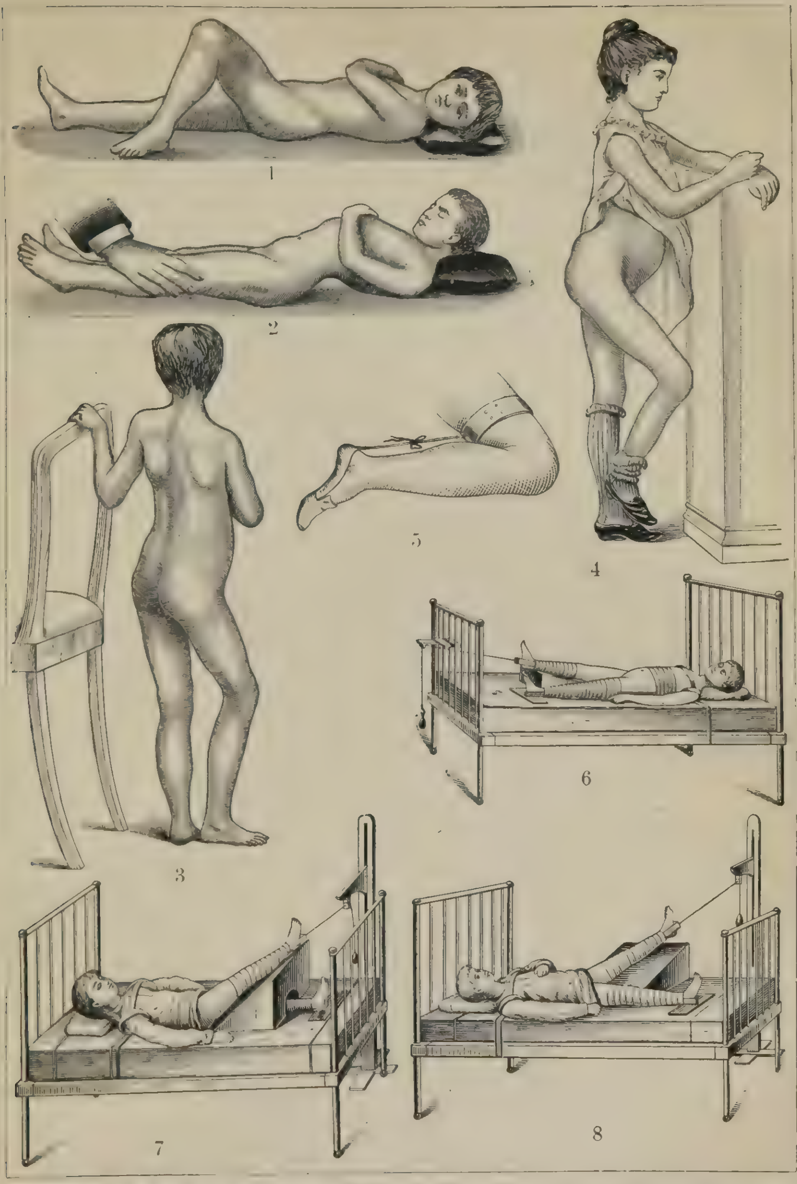
entire diseased area by erasion, by excision, or by amputation. Always remember that an incomplete operation, a partial removal, is worse than no operation, as it opens the portals to systemic infection, and may be responsible for a general tuberculosis, septicæmia, or pyæmia.

Tuberculosis of Special Joints.—**Tuberculosis of the hip-joint** (hip disease; morbus coxarius; morbus coxæ; hip-joint disease) usually begins in the epiphysis. It is commonest in children, but it may arise in adults. Traumatism and cold may be exciting causes.

Symptoms.—In tuberculosis of the hip-joint there are three stages: (1) the stage of microbic deposition and multiplication, the products of the bacilli causing irritation and new growth; (2) the stage of progression, with formation of embryonic-tissue masses and effusion into the joint; and (3) the stage of caseation, with destruction of the joint and often of the structures about it.

The symptoms of the *first stage* are slight and may be overlooked entirely. In a child there are night-terrors; on getting about in the morning the child shows some lameness, which wears off during the day, and it soon grows tired while playing and lies down to rest. There may be a slight limp; a slight adductor spasm may often be noted; some pain may occur in the hip on tapping the sole of the foot while the patient is recumbent with the leg extended; pain may be complained of at night in the hip, in the front of the thigh, or at the inside of the knee. The diagnosis in this stage is more or less problematical.

In the *second stage*, or the stage of apparent lengthening, the symptoms are positive. The child limps; the adductor muscles are rigid; the hip is broadened by an effusion in the joint, and fluctuation may possibly be detected; the thigh-muscles are atrophied; the extremity is pushed forward, abducted, and everted (the patient tilts the pelvis so as



1, 2. Effects on the Lumbar Spine of Flexing and Extending the Diseased Leg in Hip Disease (Albert). 3, 4. Positions in Coxalgia (Albert). 5. Strap-and-slipper Apparatus for Fracture of Posterior Portion of the Calcaneum (after Hamilton). 6. Extension in Hip Disease (Treves). 7. Extension of the Limb in a Flexed and Adducted Position (Treves). 8. Extension of the Limb in a Flexed and Abducted Joint (Treves).

to rest his weight on the sound limb); the thigh is somewhat flexed; in very rare instances adduction is present; pain exists, often sudden or starting, and is located in the joint, on the front of the thigh, and to the inner side of the knee in the course of the obturator nerve; the pain is aggravated at night; and full extension and complete abduction are not possible. The gluteal muscles waste, and the gluteal crease is on a lower level than is that of the sound side. Jarring of the heel when the extremity is in extension causes pain in the hip. The above symptoms arise chiefly from joint-effusion, reflex irritation, and involuntary or spasmodic muscular contractions. Lengthening in the second stage is apparent, not real, but this stage is spoken of as the "stage of lengthening." The position is shown on Plate 9 (Fig. 4). The fluid effusion may be absorbed or may find its way externally by means of sinuses. The latter condition is known as "abscess of the hip." The absorption of the exudate or the rupture of the capsule permits the contracting muscles to bring the head of the femur into firm contact with the acetabulum or its brim; the bones are worn away and destroyed, shortening results, abduction and flexion are increased, and the third stage is established.

In the *third stage* the head of the femur goes upward and outward upon the rim of the acetabulum, the thigh is flexed and fixed, and attempts at extension when the patient is recumbent cause the pelvis to tilt forward and occasion a marked lumbar curve (Pl. 9, Fig. 3), which is due to the pelvis moving with the femur as if ankylosed, and which disappears on flexion. In the third stage adduction occurs because of the ascent and movement outward of the head of the bone. Shortening is marked. After a hip-abscess finds an external outlet pyogenic infection is very apt to take place and inflammation is liable to arise, followed by that state which is designated as "hectic." If a cure follows

the third stage, partial or complete ankylosis takes place; if death ensues, it may be due to septicæmia, tuberculosis of the viscera, exhaustion, or amyloid degeneration.

Diagnosis is very easy in well-established cases of hip disease, but very difficult when the disease is incipient. Always make a systematic and thorough examination. Undress the patient and place him recumbent upon a table or a hard mattress, with the legs extended, and note if the heels are level and if the iliac spines are on the same level (depressed spine on the affected side means abducted extremity, the degree of which is determined by carrying the limb out until the spines are horizontal; elevation of the iliac spine on the affected side means adduction, the amount of which is deter-

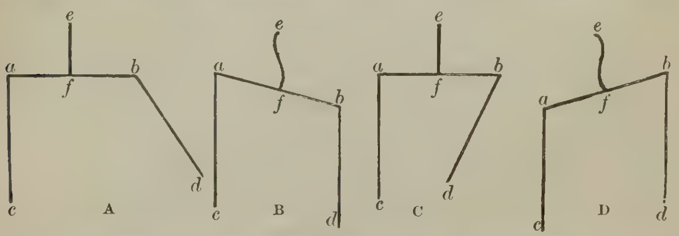


FIG. 60.—Positions in Hip-joint Disease (after the plan of Howard Marsh and Treves). A.—*e f*, lumbar spine; *b d*, limb fixed in flexion and abduction—useless for walking. B.—*e f*, lumbar spine. Patient corrects the condition in Figure A by curving the lumbar spine forward and rotating the pelvis on its transverse axis, thus making the femur point downward. The lumbar spine is curved laterally, the pelvis ascending on the sound side and descending on the affected side (apparent lengthening). C.—*b d*, limb fixed in flexion and adduction. D.—*e f*, curve of lumbar spine to correct condition in Figure C (apparent shortening).

mined by adducting the limb until the spines are horizontal; Fig. 60); try all the movements belonging to the joint, to detect any limitations; try if bringing down the knee produces lordosis (Pl. 9, Figs. 1, 2); look for swelling and for muscular wasting; feel if the head of the bone is enlarged; observe if motion produces pain or if pressure causes tenderness; and always carefully elicit the history of the attack, of the person, and of the family.

Hip disease may be confounded with spinal caries in which a psoas or a lumbar abscess has formed, with sacro-iliac disease, with infantile paralysis, with congenital dislocation, with lordosis from rickets, and with gluteal abscess. In hip disease there is always some lameness; pain may be severe or may be absent entirely, and may be in the hip or be referred to the front of the thigh or to the inner side of the knee. Always remember that the pain is not characteristic, and that pain in the same localities may arise from aneurysm of the femoral or iliac arteries, from abscess in Scarpa's triangle, from caries of the lumbar vertebræ, from sacro-iliac disease, and from cancer of the rectum. Altered position of the limb, limitation of movement in the hip-joint, muscular wasting, and swelling soon arise in hip-joint disease.

In disease of the sacro-iliac joint, examination shows that the movements of the hip-joint are unlimited and produce no pain, and that pain is developed by pressure over the sacro-iliac articulation and by pressing the ilia together. In infantile paralysis there is no pain, but paralysis with great muscular atrophy, which comes on with considerable rapidity. In spinal caries with psoas abscess the evidences of disease of the vertebræ are clear and the pus is located in the groin external to the femoral vessels. The pus of hip-abscess generally gathers under the tensor vaginæ femoris muscle, but it may reach Scarpa's triangle by passing through the cotyloid notch or through the bursa under the psoas muscle; it may appear under the glutei. Matter from a caseating acetabulum may reach the inside of the pelvis and appear above Poupart's ligament.

Prognosis.—If the case of hip disease is seen early, the chances of cure are excellent in children, in whom the disease may be arrested at any stage. The longer the duration of the disease and the older the subject, the more unfavorable is the prognosis. The cure takes many months, and

advanced cases only get well by means of ankylosis with shortening and deformity. Hip disease may recur years after apparent cure, and a person who has had hip disease runs a strong chance of developing visceral tuberculosis.

Complications.—The complications that may accompany hip disease are the following: *Abscess*, as above noted. *Tuberculous meningitis*, or the condition known as "acute hydrocephalus," or water on the brain, may arise during the progress of the case or after apparent cure, and is apt to ensue upon incomplete operations. It is almost inevitably fatal. *Amyloid*, *lardaceous*, or *waxy degeneration of viscera*, which condition follows upon profuse and long-continued suppurations, and which is apt to arise in the liver, spleen, kidneys, or intestinal mucous membrane. Tuberculosis is not the only cause, syphilis being responsible for at least thirty per cent. of all cases. In amyloid disease of the liver this organ is much enlarged, smooth, painless, and of increased consistency, there is no jaundice, the spleen is apt to be enlarged, and albuminuria is the rule. In amyloid kidney large amounts of pale urine of low specific gravity are voided; albumin is usually present in large amount, but may be absent; globulin may often be found, as may also hyaline, fatty, or granular casts; the patient is anæmic, and dropsy usually exists. Test the hyaline casts with iodine for amyloid material. Amyloid changes are usually slow in onset, but they may be rapid; they are commoner in men than in women, and are most frequently encountered in individuals between the ages of ten and thirty. Slight amyloid change may be recovered from, but an extensive degeneration brings about a fatal result. Dr. Dickson's famous theory of how this tissue-change is caused is that the flow of pus drains off from the body the alkaline salts, especially the salts of potassium, which drainage results in visceral depositions of de-alkalinized fibrin. *Phthisis pulmonalis* is a rare compli-

cation, but is a common sequence, often arising, sooner or later, after the hip disease is cured.

Treatment.—In the early stage of hip disease the treatment consists of rest. Place the patient upon a solid mattress and apply extension. In children under ten years of age, use a weight of from three to five pounds; in children between ten and twenty, use a weight of from five to eight pounds. A long splint is often applied to the sound side to keep the patient recumbent and horizontal. Apply the extension in the long axis of the limb, the extremity being placed in the line of the deformity due to disease and being supported by pillows. In lordosis from thigh-flexion, raise the limb until the iliac spine is straight (Pl. 9, Fig. 6). If the spine is depressed on the affected side, abduct the limb (Pl. 9, Fig. 7); if the spine is elevated, adduct the limb until the spines are horizontal (Pl. 9, Fig. 8). The object in taking these precautions is to enable the extension to separate the femoral head and the acetabulum. Extension will remove flexion in two weeks in a recent case and in the course of some months in an older case. As flexion is relieved remove the pillows and lower the leg so as to keep up extension in the long axis of the thigh. Abduction and adduction cannot be removed by extension. Always use a cradle to hold up the bed-clothing.

Abduction demands no special treatment. In a movable joint it will disappear, and in an ankylosed joint it is an advantage, compensating by apparent lengthening for the shortening due to bone-absorption or to stunted growth of the limb. Adduction requires an addition of several pounds to the extension weight, the use of a long splint on the sound limb, and the drawing up of the sound limb by a rope and pulley toward the head of the bed. The weight used to pull the sound side toward the head of the bed is equal to that used to pull the damaged side to the foot of the bed. This expedient is

used for a month or six weeks. In old cases where the weight will not bring about extension, anæsthetize the patient, gently straighten the limb a very little, and reapply the weight. Thomas's splint is used by many, and it may be combined with weight extension (Fig. 61); or Sayre's splint (Fig. 62) may be employed. Wyeth's apparatus (Fig. 63) is a favorite with many American surgeons.

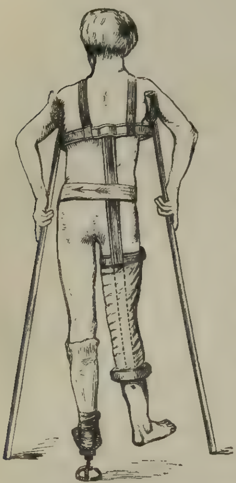


FIG. 61.—Thomas's Posterior Splint (Tiemann).

Extension in a mild case must be continued for three months after the symptoms have disappeared, and in a severe case the period must be six months. The weight is gradually taken off; if symptoms recur, the weight is reapplied; if they do not recur, apply a traction splint or a plaster dressing, put a high-heeled boot on the sound limb, and send the patient out on crutches. In young children extension can be made in a wheeled carriage, thus enabling the patient to go out in the fresh air and sunlight. The general treatment is tonic and restorative.

If an abscess forms, incise it with the most thorough antiseptic care, let the fluid drain away, wash out with corrosive-sublimate solution and then with boiled water, inject with iodoform emulsion, insert a tube, and dress antiseptically. The old plan of not operating until rupture was seen to be inevitable was bad. To open early and antiseptically often means rapid healing, the prevention of burrowing, a lessened danger of visceral infection, and an earlier cure. Hectic will not arise if the abscess is opened with antiseptic care.

Excision of the hip is to be performed when the head of

the femur is detached and lies loose in the joint; when profuse suppuration continues for a long time, and other methods fail to arrest it; when amyloid disease is beginning; or when very faulty position is inevitable without operation. Excision is an operation of considerable danger, and the older the person the greater the danger. When there is extensive

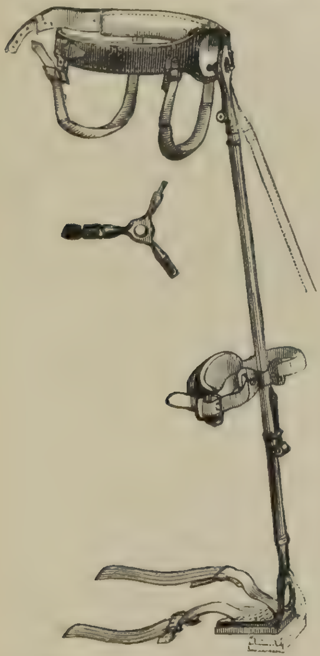


FIG. 62.—Sayre's Long Splint.

FIG. 63.—Wyeth's Combination Method.

disease of the femur, when excision has been tried and has failed, and when the patient has not the recuperative power to stand the long siege following excision, amputate.[1]

Knee-joint Disease (White swelling).—After the hip, the knee is, of all joints, the commonest site for tuberculous disease. Knee-joint disease begins as a synovitis, or oftener as

[1] See the admirable article of Howard Marsh in Treves's *Manual*.

an inflammation of the femoral or the tibial epiphysis. If an acute synovitis ushers in the case, there may be large effusion into the knee-joint and partial flexion. Swelling is usually slight in knee-joint disease. Pulpy degeneration of the synovial membrane occurs; the joint enlarges; the ligaments soften; the skin is œdematous; muscular spasm is marked; the leg is flexed; the bones are displaced backward and outward, the foot being everted; lameness exists, due chiefly to deformity; pain may be absent, is often slight, and is rarely severe. When the disease begins in the bone or an epiphysis there are pain, tenderness, lameness, swelling, inability to extend the limb completely, sudden spasmodic muscular contractions, and final involvement of the joint. When an abscess forms, it may destroy the joint very rapidly or it may break externally.

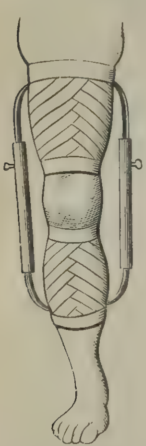


Fig. 64.—Sayre's Knee-splint Applied.

Fig. 65.—Hutchinson's Knee-joint Splint.

Treatment.—In treating knee-joint disease, employ general antitubercular treatment. Apply splints (Figs. 64, 65), extension (Fig. 66), or a plaster-of-Paris bandage, and keep the patient in bed for a few weeks; then permit him to go out with crutches, with a high-heeled shoe upon the sound foot. In cases in which treatment was begun early the disease can often be arrested in from eight to twelve months. If the symptoms do not abate after a number of weeks, or if the condition grows worse and an abscess arises, aspirate and inject iodoform emulsion. If these means fail,

open the joint and perform an excision or an erasion. Some cases demand amputation, which, if the patient's health is much impaired, is to be preferred to excision.

Ankle-joint disease begins usually as a chronic synovitis, but it may arise in the tibial epiphysis. The *symptoms* are

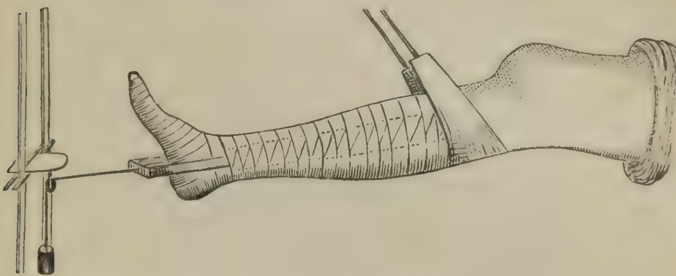


FIG. 66.—Sayre's Double Extension of the Knee-joint (Tiemann).

pain, swelling, lameness, limitation of joint-movements, and atrophy of the calf-muscles. Suppuration often occurs, and sinuses form.

Treatment.—The treatment of ankle-joint disease consists in the employment of antitubercular remedies, and of rest by means of splints or plaster. Caution the patient to avoid standing upon the diseased extremity. When suppuration occurs, open, drain, wash out with corrosive-sublimate solution and with iodoform emulsion, and put up the ankle-joint in plaster. When joint-disorganization occurs, perform an excision or an erasion. Some cases demand amputation (Syme's amputation being preferred by some, amputation above the ankle being approved by many). Osteoplastic resection is sometimes advised (Wladimiroff-Mikulicz operation).

Shoulder-joint disease, which is rare in children and is commonest in adults, begins either in the synovial membrane or in the epiphysis. Pain is slight, atrophy of the

deltoid and other muscles is noted, the joint is stiff, and the scapula follows the motions of the humerus. Suppuration is rare.

Treatment.—In treating shoulder-joint disease, employ antitubercular remedies and iodoform ointment. Put on a shoulder-cap, apply the second roller of Desault, and hang the hand in a sling. Maintain rest for at least four months. If an abscess forms, open and drain it. In rare instances dead bone will have to be gouged away. Caries sicca may occur. Excision is sometimes required.

Elbow-joint disease may begin in the humerus or the ulna. The joint is swollen, its movements are somewhat limited, the skin is usually hot, muscular wasting is pronounced, and pain is generally slight. Pus may form.

Treatment.—In treating elbow-joint disease, employ antitubercular foods, drugs, and hygienic measures; iodoform ointment locally; rest by means of an anterior angular splint (Fig. 67) and a triangular sling. If matter forms, open the

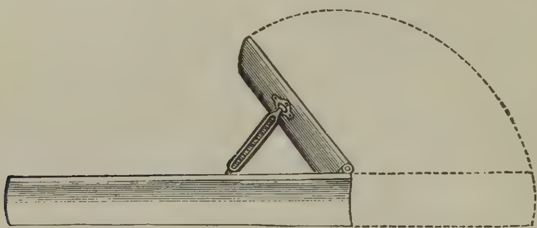


FIG. 67.—Stromeyer's Anterior Angular Splint.

joint and drain. Splints are to be worn for from four months to a year. If any considerable area becomes carious, perform an erasion or an excision.

Wrist-joint disease may arise at any age. The joint presents a puffy swelling, loses its normal contour, and becomes spindle-shaped. Hand-movements are impaired, pronation and supination cannot completely or satisfactorily

be performed, the joint is stiff and partly flexed, the grasp is enfeebled, pain may be severe or slight, the skin is usually hot, and muscular atrophy is marked.

Treatment.—The essential treatment in wrist-joint disease comprises cod-liver oil, tonics, good food and fresh air, and iodoform ointment locally. Apply a Bond splint and sling or put on a plaster bandage, and maintain rigid rest for from four to six months. Suppuration demands incision and drainage with the maintenance of rest. A moderate amount of caries is treated by drainage and rest. Necrosis demands removal of the sequestra. Extensive caries requires excision.

Septic Arthritis.—This infection is usually due to the staphylococcus pyogenes aureus or to the streptococcus pyogenes which find entrance by means of a wound, by the spontaneous evacuation into a joint of the products of an osteomyelitis, by extension of suppurative inflammation through contiguous structures, or by the blood-stream, as in pyæmia and other conditions.

Symptoms.—The symptoms of septic arthritis are—severe pain, which is aggravated by motion and is worse at night; discoloration, heat, and œdema of the skin; partial flexion of the joint; fluctuation; and marked constitutional symptoms of sepsis. The joint tends to rapid disorganization, and fatal septicæmia is very apt to occur. In pyæmic arthritis several joints become infected.

Treatment.—The treatment in septic arthritis consists in prompt incision, evacuation, antiseptic irrigation, drainage, antiseptic dressing, and immobilization. Cure is followed, as a rule, by ankylosis, but in cases treated early the joint may be preserved.

Infective arthritis arises in the course of an acute infectious disease (such as erysipelas, typhoid fever, measles, scarlatina, variola), and may be due to pyogenic cocci or to the specific micro-organism of the acute infectious disease.

Joint-inflammation arising in the course, or as a sequel, of an acute infectious disease may or may not suppurate.

Symptoms and Treatment.—If no suppuration takes place, the *symptoms* of the attack resemble those of rheumatism; if suppuration occurs, the symptoms are identical with those of septic arthritis. The *treatment* in a non-suppurative case is the same as in ordinary synovitis (p. 395). In a suppurative case, treat as in septic arthritis (p. 411).

Gonorrhœal Arthritis, or Gonorrhœal Rheumatism.—During the progress of gonorrhœa every rheumatic attack is not gonorrhœal rheumatism, for ordinary rheumatism may just as likely arise when a man has clap as when he has not this malady. Furthermore, the term is bad, as gonorrhœal rheumatism is not rheumatism at all, but is a septic or an infective disorder of the joints or of the synovial membranes, the infective material being contained primarily in the urethral discharge. This infective arthritis sometimes, though rarely, arises during the height of a gonorrhœa, but is more frequently met with in chronic cases or when the intensity of the inflammation is abating in acute cases. Men suffer from gonorrhœal rheumatism far more frequently than do women, and the seizure is very apt to recur again and again. In some cases many joints are involved, but in most cases only a few joints suffer. Osler states that the knees and ankles are most apt to be involved in a gonorrhœal rheumatism, and that this form of arthritis is peculiar in often attacking joints which are apt to be exempt in acute rheumatism ("the sterno-clavicular, the intervertebral, the temporo-maxillary, and the sacro-iliac").

Changes in and about the Joint.—The inflammation of gonorrhœal arthritis may be located around rather than in the joint, and especially in the tendon-sheaths. Suppuration is unusual, but it does occur in joints and in tendon-sheaths. Cultivation of the exudate may or may not show

the gonococci. These organisms die quickly in cultivations, and it requires a most expert bacteriologist to deny or affirm positively their presence. Osler suggests that the non-suppurative cases are due to the action of ptomaïnes taken up from the area of primary infection, and that the suppurative cases are due to infection with pus cocci.

Symptoms.—In gonorrhœal arthritis there may be transitory, intermittent, and wandering pains in and about the joint, without any other symptom; one or more joints may become swollen and painful, and moderate fever may develop. An acute inflammation with intense pain and great swelling may attack a single joint, in which case fever will be moderate unless suppuration follows. One joint, especially the knee, may swell up to an enormous extent, pain, periarticular œdema, redness, and fever being absent (hydrarthrosis, or dropsy of a joint). Suppuration in this form is rare. The tendons, the tendon-sheaths, the bursæ, and the periosteum may inflame. A case of gonorrhœal rheumatism is often very hard to check. It may last for long periods, and tends to recur again and again. Iritis, pleuritis, endocarditis, and pericarditis have been observed as complications.

The *diagnosis* between gonorrhœal rheumatism and acute rheumatism rests chiefly on the great chronicity, the slight degree of fever, the excessive tendency to recurrence, and the absence of profuse acid sweats in gonorrhœal rheumatism; and on the shorter course, the higher fever, the profuse acid sweats, the lesser tendency to rapid recurrence, the greater proneness to symmetrical involvement, and the greater frequency of cardiac and visceral complications in rheumatic fever. Furthermore, in gonorrhœal rheumatism a urethral discharge certainly exists or recently existed; in ordinary rheumatism a urethral discharge may, of course, happen to be present. Gonorrhœal rheumatism is apt to affect certain joints which acute rheumatism rarely attacks.

Treatment.—Internally, in treating gonorrhœal rheumatism, the salicylates, the alkalies, salol, and iodide of potassium are useless; iron, arsenic, strychnine, and quinine are of some benefit. In suppurative cases, incise and drain (see *Septic Arthritis*, p. 411). In non-suppurative cases, treat as in synovitis (p. 395). In lingering cases, employ massage, passive motion, flying blisters, and the hot iron; if these means fail, open the joint, wash it out with some antiseptic fluid, and dress antiseptically (or aspirate and inject).

Rheumatic Arthritis.—Acute rheumatism is a self-limited febrile malady whose characteristic features are polyarthritis, profuse acid sweats, and a tendency to heart-involvement.

Symptoms of Acute Rheumatism.—In acute rheumatism the case begins with malaise and fever, and one or more joints become affected. The inflammation spreads from joint to joint, is apt to be symmetrical, and when it arises in fresh joints it is apt to disappear quickly in those previously affected. The temperature is high, the skin sweats profusely, the joints are red, swollen, hot, and excruciatingly painful, and the structures about the joint are œdematous. After a short time the inflammation subsides in one joint and passes into another, the joint first attacked regaining its functions. Suppuration does not take place. Anæmia is pronounced, exhaustion is profound, the sweat is sour, the saliva is acid, the urine is acid, scanty, high-colored, often contains albumin, and is deficient in chlorides. Cardiac disease is apt to be caused (endocarditis, pericarditis, or myocarditis). Nodules may form upon fibrous structures, hyperpyrexia is not unusual, and cerebral or pulmonary complications may occur. Chronic rheumatism rarely follows repeated attacks of acute rheumatism, but arises insidiously in people who have been exposed to cold and damp, who have suffered from poverty, hardship, and privation, or who have had much worry. The capsule and the tendon-sheaths thicken, and there is usually

but little effusion in the joint, but the articulation becomes stiff and painful. The joint-cartilages are occasionally eroded. Muscular atrophy occurs.

Symptoms of Chronic Rheumatism.—Chronic rheumatism is indicated when the affected joints are stiff and painful and are a little swollen, but not red. Dampness and cold aggravate the symptoms. One joint or many may be affected, but usually many are involved. Passive movements cause the joint to creak and develop crepitus in the tendon-sheaths. The muscles are wasted. The joint may ankylose. Anæmia is usually pronounced. There is no fever and no tendency to suppuration, and the disease is incurable.

The *treatment* in acute rheumatism comprises the use of alkalies, salicylates, etc. (See a book upon medicine, as acute rheumatism is in the physician's province.) In chronic rheumatism, maintain the general health of the patient, give courses of iron, arsenic, and strychnine, and an occasional course of iodide of potassium or a salt of lithium, and, if possible, send him every winter to a warm climate. Turkish baths give the greatest possible relief. The waters and regimen of Carlsbad and Vichy are of immense though temporary benefit. The patient will obtain relief at the hot springs of Virginia. The patient must avoid damp and must wear woollens. Frictions, the douche, massage, flying blisters, counter-irritation with the hot iron, ichthyol ointment, and mercurial ointment are of benefit. In partial ankylosis, give ether and break up the adhesions.

Gouty arthritis, which appears especially in the smaller joints (as the fingers and the metatarso-phalangeal joint of the big toe), is due to a deposition of urate of sodium in the joint and in the periarticular structures. This irritant urate of sodium causes inflammation, inflammation forms embryonic tissue, embryonic tissue is converted into fibrous tissue, and the fibrous tissue contracts and thus deforms the joint

and limits its mobility. A great mass of urates in a joint constitutes a "chalk-stone."

Symptoms.—The premonitory symptoms may be observed for a day or so, but the acute seizure occurs early in the morning, the patient, as a rule, being aroused by excruciating pain in the metatarso-phalangeal articulation of the great toe. The joint swells, and the skin over it feels hot to the hand and becomes shiny. There is considerable fever. After a few hours the ferocity of the seizure abates, recurring again with renewed violence early the next morning, these remissions and recurrences taking place for six or eight days, when the attack subsides. In patients with chronic gout many joints are stiffened and deformed as a result of repeated attacks. Chalk-stones form, and the skin above them may ulcerate. Such patients are chronic dyspeptics, have high-tension pulses, their hearts are hypertrophied, and their urine contains albumin and casts.

The *treatment* of gouty arthritis belongs to the physician, and not to the surgeon, although to the latter the disease should be known, so that it can be diagnosticated from other maladies.

Arthritis Deformans (Rheumatoid arthritis; Osteo-arthritis; Rheumatic gout).—In this disease, which is not a combination of gout and rheumatism, the synovial membrane is affected, the cartilages are diseased, the periarticular structures are involved, and masses of new bone are formed.

Arthritis deformans has, as Prof. John K. Mitchell pointed out, a probable nervous origin. It arises especially in persons who have been worried, driven, and harassed. There is apt to be muscular atrophy; trophic lesions of the hair and nails are likely to occur, and the symptoms are disposed to be symmetrical. The causative lesion has not been determined. Rheumatic gout is commoner in women than in men. The greatest liability exists between the ages of

twenty and thirty, but children may acquire the disease, and it may also be developed in people beyond middle life. Arthritis deformans may attack the rich or the poor; it does not result from gout nor follow rheumatism, it is not caused by damp and cold, and it does not arise from traumatism. Apes in captivity may develop it.

Arthritis deformans differs from gout in the entire absence of urate deposit, and it differs from chronic rheumatism in the extensive alterations in the joint-structures. The changes begin in the cartilage; the cartilage-cells multiply, the intercellular substance degenerates, the pressure of the bone causes thinning, and at length the cartilage is entirely destroyed and the bone is exposed. The exposed bone is altered in shape, is hardened, and is worn away in the centre, the periphery increasing in thickness by ossific deposit; thus the centre becomes deepened by absorption and the periphery bulged and lengthened by deposit. The fringes of the synovial membrane hypertrophy and multiply, and some of them are apt to break off (loose cartilages). The capsule and the ligaments of the joint, as a rule, become fibrous and contract, but they may soften, relax, and permit of dislocation. The joint usually contains no effusion, but in some cases there is great effusion (hydrarthrosis). The tendons about the joint may become fibrous and contracted, they may ossify, they may be separated from the bone, or they may be destroyed entirely. Deformity is marked and motion is limited. The fingers, when involved, show nodules on the sides of the joints (Heberden's nodules). The vertebræ may be involved. Almost all the joints may suffer. Suppuration does not occur.

Symptoms.—Charcot classifies arthritis deformans into three forms, and gives their symptoms as follows:

(1) *Heberden's nodosities*, which condition is commoner in women than in men, comes on between the ages of thirty

and forty, and is especially common in neurotic subjects. The interphalangeal joints become the victims of attacks of moderate swelling and of some tenderness, which attacks are not severe, but recur again and again. After a time small hard swellings (nodosities) appear upon the sides of the dorsal surfaces of the second and third phalanges, remain permanently, and slowly increase in size. The joints become stiff and creak on movement, the cartilage is destroyed, and contractions and rigidity develop, but there is no fever and the larger joints are not involved. The malady is incurable.

(2) *Progressive rheumatic gout*, which may be acute or chronic. The *acute* form begins as does rheumatic fever. There are moderate fever, and swelling, but no redness, of a number of joints, of bursæ, and of tendon-sheaths; the joints are stiff and crepitate, and are apt to be symmetrically involved; muscular atrophy begins early and rapidly becomes decided; pain is slight. This acute form is apt to arise in young women after pregnancy, but is not unusual at the climacteric and in children. Anæmia always exists. The case is apt to advance progressively until a number of joints are firmly locked, when it may become stationary. A fresh pregnancy will develop anew the acute symptoms. In the *chronic* form swelling and pain on movement are noted in certain joints. The involvement is apt to be symmetrical. Attacks of swelling and pain alternate with periods of quiescence, but the disease does not cease its advance. Articulation after articulation is attacked by the malady until almost all the joints are involved; deformity and stiffness become pronounced, and pain may or may not be severe. There is no fever. Muscular atrophy is marked.

(3) *Partial rheumatic gout* attacks one articulation, and it is most often met with in old men. It may fix itself on the vertebral column, on the knee, on the shoulder, on the

elbow, or on the hip. The joint grates and becomes stiff, swollen, and deformed; the muscles atrophy; there is usually pain, but fever is absent. Partial rheumatic gout of the hip-joint in an old person is known as "morbus coxæ senilis," and partial rheumatic gout of the vertebral articulations causing fixation is called "spondylitis deformans."

Treatment.—Rheumatic gout cannot be cured, but in some cases it remains stationary for many years. Treat the anæmia by iron, arsenic, good food, and fresh air. Debility is met by strychnia. Hot baths of mineral water do good. Massage retards the progress of the case, relieves the pain, helps the absorption of the effusion, and delays fixation. During an acute exacerbation the joint should be put at rest for a day or two, and there should be used lead-water and laudanum, cold water, or tincture of arnica. Douches and hot baths improve these cases, but electricity is entirely useless. Counter-irritants do no good. The patient is unfortunately liable to develop the opium habit. In dropsy of a joint, if it arises, try compression with a Martin bandage, and if this fails, aspirate and inject carbolic acid. Patients with rheumatic gout do best in a warm dry climate. Cod-liver oil does good, as it improves nutrition and hence retards the progress of the disease. Do not be tempted to immobilize the joints beyond a day or two: fixation only hastens ankylosis.

Charcot's Disease (Tabetic arthropathy; Charcot's joint; Neuropathic arthritis).—This condition is an osteo-arthritis due to trophic disturbance, arising in a sufferer from locomotor ataxia, and is anatomically identical with rheumatic gout. The knee is most apt to be attacked. The disease begins acutely, often as a sudden effusion which after a time disappears. Pain is slight or is absent, there is no constitutional involvement, and the condition is unconnected with injury. The bones and cartilages are rapidly destroyed; fracture is

apt to occur; the joint creaks and grates; the softening and relaxation of ligaments permit an extensive range of movement; great deformity ensues; dislocation is apt to occur; muscular atrophy is decided; and pus occasionally, though very rarely, forms.

Treatment.—The treatment of Charcot's disease consists in the wearing of an apparatus to sustain the joint. Resection is recommended by some, but most surgeons do not advise its performance.

Hysterical joint (Brodie's joint) is a condition mostly encountered in young women. The disease occurs in the knee and the hip, and often follows a slight injury which acts as an auto-suggestion, a latent hysteria being awakened into action and localized, though severity of the injury does not determine the severity of the symptoms. The disease may ensue upon an arthritis or may arise without apparent cause. The patient resists passive motion strenuously and claims that it causes much pain. There is occasionally some muscular atrophy from want of use, and the joint is a little swollen. The skin is hyperæsthetic, and a light touch causes more pain than does deep pressure. The muscles may be rigid. The joint may be maintained either in flexion or in extension, but it is rarely in the exact degree of flexion assumed for ease in a true joint-inflammation, and the position is apt to be changed from day to day or from hour to hour. The skin is usually cool, but may be hot, and a periodically developed heat may be observed, especially at night, accompanied apparently by much pain. The pain in some cases is a neuralgia, but in most cases is a pain hallucination. In some rare cases organic disease arises in a hysterical joint.

Hysterical phenomena are seldom isolated, but are associated with certain stigmata which may be latent. These stigmata are concentric contraction of the visual fields, pharyngeal anæsthesia, convulsions, hysterogenic zones,

globus hystericus, clavus hystericus, zones of anæsthesia, especially hemianæsthesia and hyperæsthetic areas. Such patients are predisposed by inheritance, and have previously, as a rule, had nervous troubles. Hysterical phenomena, be it remembered, lack regularity of evolution, and are produced, altered, or abolished by mental influences and physical sensations which are without effect in causing, modifying, or curing organic disease. The general health, as a rule, is good, but neurasthenia may coexist. In examining these patients the observer will note that the symptoms disappear when the attention is diverted, that they are out of all proportion to the local evidences of the disease, that there is no evidence of joint-destruction, and that light touching causes more pain than does firm pressure. If the patient is anæsthetized, perfect joint-mobility will be found.

Treatment.—The treatment in hysterical joints comprises attention to the general health, the employment of nourishing and easily-digested food, the prevention of constipation, and the administration of tonics if they are needed. The surgeon must dominate his patient's mind and make her realize that he is master of the case. He is to be an inexorable but just ruler—never a brutal or a cruel one. If possible, send the patient away from the sympathies of her home and let her have the rest treatment of Weir Mitchell. Local remedies applied to the joint do harm, as a rule, by concentrating afresh the patient's attention upon the articulation, although the hot iron sometimes does good. Suggestion in the hypnotic state may be tried. The use of morphia should be avoided as being the worst of enemies. Never immobilize the joint, and always use massage, passive motions, and frictions.

Neuralgia of the joints as an independent, isolated affection is extremely rare, though as a complication of other diseases it is by no means uncommon. The neuralgia is more

often around the joints than in them, and is especially frequent in the knee and the ankle. Joint-neuralgia may arise in any person, but it is more commonly present in young neurotic females. The pain may be persistent or it may occur in periodic storms, and it is often linked with neuralgia in other parts. The pain may be dull and aching, but it is more often sharp and shooting. Joint-neuralgia is associated with tenderness on pressure, soreness on motion, often with transitory swelling without redness, and sometimes with numbness of the extremity. The *diagnosis* depends on the temperament of the patient, the sudden onset of the pain, the absence of constitutional symptoms, and the free mobility of the joint, especially under ether. Articular neuralgia may depend upon disease or injury of the central nervous system, upon malaria, syphilis, neurasthenia, rheumatism, gout, hysteria, and neuritis, and may be due to reflected irritation, especially from the ovaries, the womb, and the rectum.

Treatment.—The treatment to be observed in joint-neuralgia is to maintain the general health; examine for a possible exciting cause, and, if found, remove it; give a long course of iron, quinine, and strychnine or of arsenic. In rheumatic or gouty subjects give suitable drugs and insist upon proper diet. During the attack use phenacetin. Morphia must occasionally be used in severe cases, but be careful of it, and never tell the patients they are taking it, as there is a liability of their forming the opium habit. Locally, employ frictions, ointment of aconite, and heat, and keep upon the part a piece of flannel soaked in a mixture of soap liniment, laudanum, and chloroform (Gross). Never let a joint stiffen; any tendency to do so should be met by daily massage, frictions, passive motion, and the hot and cold douche. In some rare cases nerve-stretching or neurectomy becomes necessary.

Articular Wounds and Injuries.—A *non-penetrating*

wound requires antiseptic irrigation, stitching, and antiseptic dressing upon a splint. A *penetrating* wound is very serious, and it may be due to compound fracture (p. 307), to compound dislocation (p. 435), to gunshot wounds, or to stabs. If a bursa near a joint be injured, secondary penetration may occur as a result of suppuration. In a penetrating wound, besides pain, hemorrhage, and swelling, there is a flow of synovial fluid. A small amount of synovia flows from an injured bursa, a large amount from an open joint.

Treatment.—If a joint is opened aseptically (as when incised by the surgeon), it gets well nicely under rest and antisepsis. If a joint is opened by a septic body, suppurative arthritis is apt to arise, and the indications are to irrigate, drain, dress antiseptically, and secure rest. In gunshot wounds, if antisepsis is not employed, suppuration is inevitable; hence military surgeons, as a rule, have advocated amputation or excision in gunshot splinterings of large joints. In these injuries the wound is enlarged, the finger is introduced to discover and remove foreign bodies, through-and-through drainage is secured, a tube is inserted, the joint is irrigated, antiseptic dressings are applied, and the extremity is placed upon a splint. Very severe cases demand resection or even amputation. Ankylosis more or less complete follows a gunshot wound of a joint. If the joint suppurates, the drainage must be made more free, sinuses must be slit up and packed, sloughs must be cut away, dead bone must be gouged out, and the patient must be placed upon a stimulant and tonic plan of treatment.

Sprains.—A sprain is a joint-wrench due to a sudden twist or traction, the ligaments being pulled upon or lacerated and the surrounding parts being more or less damaged. A sprain is often a self-reduced dislocation. The joints most liable to sprains are the knee, the elbow, and the ankle. The smaller joints are also often sprained, but the ball-and-

socket joints are infrequently sprained, their normal range of free movement saving them; they do occasionally suffer severely, however, as a result of abduction. In a bad sprain the ligaments are torn; the synovial membrane is contused or crushed; hemorrhage takes place into and about the joint; muscles and tendons are stretched, displaced, or lacerated; vessels and nerves are damaged; the skin is often contused; and portions of bone or cartilage may be detached from their proper habitat, though still adhering to a ligament (sprain-fractures). Sprains are commonest in young persons and in adults. A joint once sprained is very liable to a repetition of the damage from slight force. Sprains are common in a limb with weak muscles, in a deformed extremity in which the muscles act in unnatural lines, and in a joint with relaxed ligaments.

Symptoms.—The symptoms manifested in sprains are as follows: severe pain in the joint, accompanied by weakness, nausea, often by vomiting, and sometimes by syncope. Impairment or loss of motion is present. This condition is succeeded by a season of relief from pain while at rest, numbness being complained of, and pain on motion being severe. Very soon swelling begins if hemorrhage is severe. In any case swelling begins in a few hours. Movement of the joint becomes difficult or impossible; the tear in the ligament may be distinctly felt; pain and tenderness become intense; joint-crepitus will be detected; and in a day or two discoloration becomes marked.

Diagnosis and Prognosis.—Sprain-fractures cannot be diagnosticated with certainty. The *diagnosis* must be made from fracture and dislocation. In fracture, crepitus and mobility exist; in dislocation, rigidity. The diagnosis should be made by a consideration of the joint involved, of the age, of the nature of the force, by the length of the limb, by the fact that the patient could use the joint for at least a short

time after the accident, and by the local feel and movements of the part. The *prognosis* depends on the size of the joint, on the extent of laceration, and on the amount of intra-articular hemorrhage. The danger is ankylosis.

Treatment.—The indications are, first, to limit inflammation, and, secondly, to restore the functions of the joint. In a mild sprain use lead-water and laudanum or apply at once a silicate dressing. In a severe sprain place the extremity upon a splint and to the joint apply flannel kept wet with lead-water and laudanum, iced water, tincture of arnica, alcohol and water, or a solution of chloride of ammonium. The ice-bag should from time to time be laid upon the flannel for periods of twenty or thirty minutes. Leeches around the joint do good. Constitutionally, employ the remedies for inflammation (p. 60). Morphia or Dover's powder is given for the pain. Judicious bandaging limits the swelling.

After a day or two, if the symptoms continue or if they grow worse, use hot fomentations, hot lead-water and laudanum, the hot-water bag, plunge the extremity frequently in very hot water, or apply heat by Leiter's tubes. When the acute symptoms begin to subside, rub stimulating liniments upon the joint once or twice a day and employ firm compression by means of a bandage. Many cases do well at this stage under the local use of ichthyol and lanolin (50 per cent.), tincture of iodine, or blue ointment. Later in the case, use the hot and cold douche, massage, frictions, passive motion, and the bandage. Give iodide of potassium, often use tonics internally, and insist on open-air exercise. Many sprains may be put up in an immovable dressing about the first day or two after the accident. If the joint contains much blood, aspiration should be practised before the dressing is applied.

Ankylosis.—When a joint-inflammation eventuates in

the formation of new tissue in and about the joint, contraction of this tissue limits or destroys joint-mobility, producing the condition known as "ankylosis." Ankylosis may be complete (bony) or incomplete (fibrous); it may arise from contractures in the joint (true or intra-articular ankylosis) or from contractures in the structures external to the joint (false or extra-articular ankylosis).

True or *intra-articular* ankylosis may arise from any cause which produces joint-inflammation with formation of new tissue, and may be due to wounds, contusions, sprains, dislocations, fractures in or near a joint, movable bodies in a joint, tubercle, gout, rheumatism, or syphilis. Want of use of the joints causes partial ankylosis, though this has been denied. Ankylosis is more apt to take place in a hinge-joint than in a ball-and-socket joint. In ankylosis from a general cause (as rheumatic gout) many joints are apt to suffer. Ankylosis may be due to fibrous tissue, and is then usually partial; it may be due to chondrification of fibrous tissue, and is then incomplete; it may be due to ossification of fibrous tissue, and is then complete, the joint being entirely immobile (osseous or bony ankylosis). The entire joint may be converted into bone. Only one small joint-surface may contain adhesions (limited adhesion), or the entire joint-surface may be bound up in them (diffused adhesion).

Fibrous ankylosis follows aseptic inflammations; bony ankylosis is apt to follow infections. Though some motion is usually possible in fibrous ankylosis, in some cases it may be impossible. A joint immovable from fibrous ankylosis is distinguished from a joint immovable from bony ankylosis by the fact that in the former attempts at motion are productive of pain, and subsequently of inflammation. The incapacity resulting from ankylosis is due, first, to the impairment or destruction of joint-function, and, secondly,

to the fixation at an inconvenient angle (a fixed flexed knee is worse than a fixed extended knee; a fixed extended elbow is worse than a fixed flexed elbow).

Treatment.—The effort should always be made to prevent an ankylosis by treating carefully any joint-inflammation and by beginning passive motion at the earliest safe period. To limit inflammation is to prevent ankylosis. Many cases of fibrous ankylosis are improved by passive movements, massage, frictions, stimulating liniments, inunctions of ichthyol or mercurial ointment, hot and cold douches, and electricity. Some cases may be straightened out slowly by screw-splints or by weights and pulleys. Fibrous ankylosis of the elbow is best treated by using the joint. Fibrous ankylosis is often corrected by forcible straightening. If the tendons are much contracted, tenotomy should be performed two or three days before forcible straightening is attempted. In order to straighten, always give ether. Suppose a case of ankylosis of the knee: put the patient upon his back, bring the leg over the end of the operating-table, grasp the ankle with one hand and the lower portion of the leg with the other hand, and make strong steady movements of flexion and extension until the limb can be straightened. The adhesions will be felt to break, the snapping often being audible. At once apply a plaster-of-Paris dressing, and keep the limb immobile for two weeks. This procedure is not free from danger. Vessels may be ruptured, nerves may be torn, skin and fascia may be lacerated, suppuration may ensue from the admission into the joint of encapsuled cocci, or organisms in the blood may find this area a *point of least resistance.* Because of the danger of opening up depots of encapsuled bacilli and cocci, do not forcibly break up an ankylosis that results from a tubercular or a septic arthritis, but use gradual extension by weights or by screw-splints. Ankylosis of the

knee following fracture of the patella is almost sure to recur after forcible breaking up. The best treatment for knee-ankylosis is use of the joint. In bony ankylosis of any joint other than the elbow-joint, do nothing if the joint is in a useful position. If the joint is in an unfortunate position, resort to excision or an osteotomy. In the elbow, excision should be performed, no matter what the position, in the hope of obtaining a movable joint.

False or Extra-articular Ankylosis.—In this disease the joint is intact, but the contractures are in surrounding parts. The causes are muscular and tendinous contractures, cicatrices (especially from burns), deposits of bone, muscular paralysis, tumors, and aneurysm. Contractions of muscles or tendons may be due to gout, rheumatism, injury, thecitis, fractures, and dislocations. False ankylosis is seen in club-foot and in Dupuytren's contraction.

Treatment.—The treatment of false ankylosis depends upon the cause. Recently-contracted muscles or tendons require motions, massage, frictions with stimulating liniments, and the hot and cold douche. Old contractions require division. Whenever possible, excise a cicatrix that causes false ankylosis, and fill the gap with good tissue. Bony deposits are gouged away and tumors are removed. Paralysis requires electricity, passive motion, frictions with stimulating liniments, and general treatment.

Loose Bodies in Joints (Floating Cartilages).—In this affection the knee is the joint oftenest affected. These bodies may be free, may have a stalk or pedicle, may move about and occasionally block the joint, or may lie quietly in a joint-recess or diverticulum. They may be single or multiple, flat or ovoid, smooth or irregular, as small as peas or as large as plums, and may be composed of fibrous tissue, of bone, or of cartilage. There are numerous different modes of origin of these bodies, many being " detached

ecchondroses or pieces of hyaline cartilage hanging by narrow pedicles" (Bland Sutton), and they result from enlargement and chondrification of the villi of the synovial membrane. Some loose bodies are broken-off osteophytes; some arise from blood-clots; some by projection or herniation of the synovial membrane, which protrusion is broken off; others are detached fringes of tubercular synovial membrane. Traumatism is usually an exciting cause. Loose cartilages are commonest in adult men.

Symptoms.—Many small bodies give rise to no symptoms other than those of synovitis. A large body produces pain and interferes with joint-function. The joint is weak and a little swollen, and the patient can feel the body and often can push it into a superficial area of the joint, where it can be felt by the surgeon. From time to time the body may get caught, thus suddenly locking the joint and producing intense and sickening pain, extension and flexion being impossible until the body slips out, and inflammation and effusion following the accident.

Treatment.—To relieve locking, employ forced flexion and sudden extension. Cure can be obtained only by operation. Let the patient bring the foreign body to a point where it can be felt; the surgeon then fixes it with a pin or holds it with the fingers, ether being given or cocaine being used. The joint is now opened, the foreign body extracted, and an exploration is made to see that no other bodies are present. The wound is now stitched and the leg is placed upon a splint. Antisepsis must be most rigid. The operation does not cure the causative lesion, and these bodies are apt to form again.

4. Luxations or Dislocations.

A dislocation is the persistent separation from each other, partially or completely, of two articular surfaces. A sprain

is a self-reduced dislocation. There are three forms of dislocation: (1) traumatic; (2) spontaneous or pathological; and (3) congenital.

1. **Traumatic dislocations** are due to injury. They are divided into—*complete* dislocation, in which the two articular surfaces are entirely separated and the ligaments are torn; *incomplete* or *partial* dislocation, in which the two articular surfaces are not completely separated and the ligaments are rarely lacerated; *simple* dislocation, in which the articular surfaces are not brought into contact with the external air; *compound* dislocation, in which the external air has access to the articular surfaces; *complicated* dislocation, in which, besides the dislocation, there is a fracture, extensive drainage of the soft parts, an opening admitting air to the soft parts, or damage of a nerve or blood-vessel; *primitive* dislocation, in which the bones remain as originally displaced; *secondary* dislocation, in which the bone assumes a new position: for instance, a subglenoid luxation of the humerus is primary, and it may become secondarily a subcoracoid luxation because of muscular contraction or attempts at reduction; *recent* dislocation, in which the displaced bone is not firmly fastened by tissue-changes in its new situation, and its old socket is not obliterated; *old* dislocation, in which the displaced bone is firmly fastened by tissue-changes in its new habitat, and the old socket is to a great extent obliterated (whether a dislocation is old or new depends on the state of the parts rather than on the time which has elapsed since the accident); *double* dislocation, in which corresponding bones on each side are dislocated; *single* dislocation, in which only one joint is dislocated; *unilateral* dislocation, in which one articulation of one bone is out of place; *bilateral* dislocation, in which symmetrical articulations are dislocated; and *relapsing* or *habitual* dislocation, which recurs constantly from slight force because of relaxed

ligaments or lack of complete repair after the ligamentous rupture of a first dislocation.

2. **Spontaneous, Pathological, or Consecutive Dislocations.**—Spontaneous dislocation arises from such very slight force that it often cannot be identified, and it acts on a joint rendered lax by disease. It may arise in the course of chronic synovitis and during tubercular joint-disease. In Charcot's joint (*arthropathie des ataxiques*) this form of dislocation constantly appears. This condition comes on in a few hours, during the progress of locomotor ataxia, and is without apparent reason. The knee, the shoulder, or some other joint becomes greatly swollen, fluid gathers in large amount, the ligaments relax, the joint is destroyed and becomes excessively mobile, but there is no pain, no fever, and no sign of inflammation.

3. **Congenital Dislocations.**—The third form, or congenital dislocation, is due to a congenital joint-malformation which renders it impossible for the bone to maintain a normal position, or is due to external violence during the period of uterine gestation. Congenital dislocations should not be confounded with dislocations produced during delivery.

Traumatic Dislocations.—In the succeeding pages the traumatic form of dislocations will particularly be considered. The *causes* of traumatic dislocations are divided into *predisposing* and *exciting*.

Predisposing causes are (1) *Age*—dislocations are commonest in middle life the usual lesion of the young being green-stick fracture, and that of the old being fracture. Dislocations of the radius are not uncommon in youth. (2) *Muscular development*—dislocations being commonest in those with powerful muscles. (3) *Sex*—males being more predisposed than females, because of their occupations and muscular strength. (4) *Occupation* predisposes as a cause according as it demands the employment of muscular force,

as in the carrying of burdens. (5) *Nature of the joint*—ball-and-socket joints being more liable to luxation than are ginglymus joints, because of their wide range of motion. (6) *Joint disease* predisposes by relaxing the ligaments. (7) *Situation of the joint*—some joints being more exposed to injury than others.

Exciting causes are classified into (1) external violence and (2) muscular action. *External violence* may be *direct*, as when a blow upon one of the bones forces it directly away from the other; or it may be *indirect*, as when a blow at a distant part of a bone transmits force to its end and drives the bone out of its socket. *Muscular action* is a cause when sudden and violent muscular contraction occurs during the existence of a position of the joint which gives the muscles full sway, and throws the head of the bone against the weakest part of its retaining ligaments.

Pathological Conditions.—In a recent complete traumatic dislocation the ligaments are damaged, and may perhaps show extensive laceration, or may show only a button-hole laceration through which a bone projects. External force produces much laceration and little stretching of the ligaments; muscular action produces little laceration and much stretching of the ligaments (Mears). In some cases of dislocation due to external violence the structures about the joint are bruised or otherwise damaged; the old socket is filled with blood, and the bone in its new situation lies in a bloody area. Large vessels and nerves are rarely torn, though they may be compressed.

If a dislocation is not soon reduced, inflammation arises in the old joint and about the displaced bone, and the whole area is glued together, first by coagulated exudate, and next by embryonic tissue. After a time, in ball-and-socket joints, the old socket fills with fibrous tissue, contracts, becomes irregular, and may even be obliterated; the head of the dis-

located bone alters its shape, its cartilage is destroyed or converted into fibrous tissue, and the pressure of the head of the bone forms a hollow in its new situation, which hollow becomes surrounded by fibrous tissue or even by bone. A new joint may form, the surrounding tissue becoming a compact capsule, and a bursa forming between the head of the bone and its new socket. In a dislocated hinge-joint the ends of the bone alter greatly in shape and their cartilage is converted into fibrous tissue. In an unreduced dislocation the muscles shorten or lengthen or undergo atrophy or fatty degeneration, as the case may be. An unreduced dislocation of a ball-and-socket joint may give a fairly movable new joint, but an unreduced dislocation of a hinge-joint rarely allows of much motion.

General Symptoms of Traumatic Dislocations.—In general, traumatic dislocations are indicated (1) by *pain* of a sickening, nauseating character; (2) by *rigidity* (voluntary motion is impossible except to a slight extent in the direction of the deformity. For instance, in dislocation of the inferior maxillary the jaw can be opened a little more, but it cannot be closed. This rigidity brings about loss of function. When the surgeon attempts to move the joint he finds it very rigid); (3) by *change in the shape of the joint* (as flattening of the shoulder after dislocation of the humerus); (4) by *alteration in the mutual relations of bony prominences about a joint* (alteration of the relation between the olecranon and humeral condyles in dislocation of the elbow backward); (5) by feeling the displaced bone in its new situation; (6) by missing the head of the bone from its proper situation; (7) by alteration in the length of the limb (in dislocation of the femur into the thyroid foramen the leg is lengthened, but in dislocation into the dorsum of the ilium it is shortened); and (8) by alteration in the axis of the bone (in dislocation upon the dorsum of the ilium the axis of the injured thigh

would, if prolonged, pass through the lower third of the sound thigh).

Diagnosis of Traumatic Dislocation.—A dislocation may be mistaken for a fracture. In dislocation there is rigidity, in fracture there is preternatural mobility; in dislocation there is no true crepitus (may get tendon- or joint-crepitus), in fracture there usually is crepitus; in dislocation the deformity does not tend to recur after reduction, in fracture it does recur after extension is relaxed. In a sprain the movements of the joint are only limited, not abolished by an almost complete rigidity. The change which a sprain may cause in the shape of a joint is due to effusion or to bleeding; there is no alteration in the relation of the bony prominences to one another; there is no notable alteration in the length of the limb (a slight increase in length may arise from joint-effusion, or the head of the bone may subsequently be absorbed, and thus produce shortening after some weeks); there is no alteration in the axis of the bone; the head is not felt in a new position, it being found in its normal place. Always remember that a fracture may exist with a dislocation. In any doubtful case—in fact, in most cases—give ether, for a dislocation should be reduced while the patient is anæsthetized (except in dislocation of the jaw, of the fingers, of the carpus, etc.). In some cases swelling renders the diagnosis difficult or impossible. Always compare the injured joint with the corresponding joint of the sound side.

Treatment of Traumatic Dislocations: Recent Simple Dislocations.—Reduce simple dislocations under ether, as a rule. Try *manipulation*, a procedure in which it is sought to make the bone retrace its own pathway. If this procedure fails, employ extension and counter-extension. If considerable force is needed, an assistant makes counter-extension, and the surgeon fastens to the extremity a clove-hitch which he ties about his waist, and thus secures powerful extension.

Counter-extension may be obtained by bands or, in some instances, by the foot of the surgeon. The clove-hitch is used because it will not tighten by traction, as a tightening band would lacerate the soft parts (Fig. 68). If great power is needed, compound pulleys may be employed, such as the Jarvis adjuster or some similar appliance (see pages 447, 459). If these means fail, cut down upon the bone and restore it to position. After reducing a dislocation, immobilize the joint for a time (time varies with different joints), and for the first few days combat swelling and inflammation with evaporating lotions. If there exists a fracture of the dislocated bone, apply splints and then try to reduce by manipulations, grasping the limb and the splint with one hand below and, if possible, with the other hand above the seat of the fracture. In some cases with fracture reduction can be much aided by screwing a gimlet into the head of the bone and using this tool as a handle. If the fracture is near the joint and the fragments cannot be fixed, try to reduce the dislocation, first striving to press the bone into place.

Compound Traumatic Dislocations.—The opening in the soft parts may be due to external violence or to projection of a bone. Compound dislocations are very serious. Hinge-joints are more often victims to these injuries than are ball-and-socket joints. Many cases require excision and amputation; all that do not demand excision or amputation are treated by counter-opening, by careful antisepsis, by drainage, and by immobilization, ankylosis generally ensuing, except sometimes in the small joints. It is scarcely ever necessary to cut away any portion of the protruding bone to effect reduction. If a joint is badly splintered or if the soft parts are extensively damaged, excise or amputate; if the main vessels or the nerves are seriously injured, or if the patient is so old or so feeble that it is perilous to force him to combat a long illness, then amputate.

Old Traumatic Dislocations.—The problem always presented in old dislocations is, Shall reduction be tried, or shall the bones be left alone? Sir Astley Cooper laid down this rule: "Do not attempt to reduce a shoulder-dislocation after three months, nor a hip-dislocation after two months;" but this rule was laid down before the days of ether. Do not select any fixed period of time to determine the action. In dislocation of a ball-and-socket joint considerable motion may become possible and a new joint may form. If movement does not produce pain, a good new joint may eventually be obtained by faithful passive movements; if movement of the limb does produce pain, enough motion will not be attempted by the patient to produce a useful joint. In the former case try to obtain a useful new joint, and in the latter case try to reduce the old dislocation.

In trying to reduce an old dislocation, give ether, make movements to break up adhesions, and persist in making these motions until the head of the bone is felt to move; then try at once to reduce by manipulation, extension, or the pulleys, not waiting for two days, as some suggest. If the head of the bone cannot be made to move, there may be followed the Dieffenbach plan, which is to cut the tense restraining bands with a tenotome. Always remember that dislocations of a hinge-joint, if left unreduced, will never eventuate in a useful artificial joint. Sir Joseph Lister, being much impressed with the danger inevitably linked with forcibly dragging old dislocations into place, prefers to cut down and restore the bone, employing, of course, the fullest antisepsis.

Special Traumatic Dislocations: Lower Jaw.—Without fracture the lower jaw can only be dislocated forward. There are two forms of dislocation—the *unilateral*, which is rare, and the *bilateral*, which is common. Dislocations of the jaw are commonest in women and during middle life.

When the mouth is open contraction of the external pterygoid can pull the condyle over the articular eminence; this contraction may be brought about by yawning, vomiting, scolding, etc. When the mouth is open dislocation of the lower jaw can be caused by a blow upon the chin; it can also be caused by forcing the mouth more widely open by pushing a bulky body between the teeth.

Symptoms of Lower-jaw Dislocations.—In the *bilateral* form the mouth is open and fixed, and it cannot be closed, though it can be opened a little more. The condyles are in front of the articular eminences, and are fixed by the action of the masseters and internal pterygoids, the coronoid processes being wedged against the malar bones. The lower jaw is advanced in front of the upper and the face looks longer than natural. The lips cannot close, the saliva overflows, swallowing and speech are difficult, there is a depression in front of the ear, the condyle is recognizable in its new abode, the coronoid process is detected by a finger in the mouth, and the masseters and temporals stand out in a state of rigidity. Pain may be severe or be absent. In the *unilateral* form the chin goes toward the sound side, and the mouth is not so widely open as in the bilateral form, neither is the jaw so fixed. The symptoms are similar to those of a bilateral luxation, but are not so pronounced. The hollow in front of the ear and the condyle in an abnormal situation are only detected upon one side. In an unreduced dislocation the patient may after a time establish some movement of the jaw, but the power of mastication will always be impaired seriously.

Treatment of Lower-jaw Dislocations.—In treating dislocations of the lower jaw the patient is placed with his head against the back of a chair or against the body of an assistant. The surgeon, after wrapping up his thumbs to save them from being bitten, stands in front of the patient, puts

his thumbs upon the last molar teeth, and grasps the chin with his free fingers. He now presses downward and backward on the jaw, and as soon as the condyle is loosened closes the jaw over the condyle by pushing up the chin, using his thumbs as levers. If this procedure fails, wedges should be put between the molar teeth and the chin should be pushed up either by the hands or by a tourniquet whose band is round the head and chin. In a unilateral dislocation the wedge should only be used on the injured side. In difficult cases Sir Astley Cooper took a round wooden ruler and pushed it between the molar teeth, using the upper teeth as a fulcrum and raising the end of the ruler as the handle of a lever. The forceps used by an anæsthetizer may depress the condyle from its point of fixation, whereupon the chin may be pushed up and back. Nélaton's plan was to put the thumbs in the mouth and push the coronoid processes backward. In an old dislocation always try reduction, at least up to a period of six or seven months. After reduction apply a Barton bandage for over two weeks, taking it off once a day, and begin passive motion in the second week; discard the bandage in the third week. Liquid diet is advisable for three weeks after the accident.

Dislocation of the Clavicle: Sternal End.—There are three forms of dislocation of the sternal end of the clavicle, namely: (1) forward; (2) backward; and (3) upward.

Forward Dislocation of the Clavicle.—The *causes* of forward dislocation of the clavicle are blows, falls, or pulls which drive or draw the shoulder backward.

Symptoms and Treatment of Dislocation of the Clavicle.—The symptoms manifest in dislocation of the clavicle are—prominence in front of the sternum; the acromion is nearer to the sternum on the injured than on the sound side; the clavicular origin of the sterno-cleido-mastoid is rigid; movement is difficult and painful. To treat a dislocation of the

clavicle, pull the shoulders back against the knee placed between the scapulæ. Dress with a posterior figure-of-8 bandage (Pl. 12, Fig. 5) or a Velpeau bandage (Pl. 13, Fig. 4), the dressing to be worn for three weeks. After removal of the dressing apply a truss the pad of which is put over the head of the clavicle, and which instrument is to be worn for a month. Dislocation of the clavicle is difficult to keep reduced, but even if it becomes fixed in deformity the motions of the arm will not be impaired permanently.

Backward dislocation of the clavicle is very rare. The *causes* are direct violence and indirect force, such as falls or blows which drive the shoulder forward and inward.

Symptoms and Treatment of Backward Dislocation of the Clavicle.—The symptoms are—pain; loss of function in the arm; inclination of head toward the injured side; stiffness of the neck; the shoulder passes forward and inward, and often falls downward; a depression exists over the sterno-clavicular joint; the head of the clavicle cannot be felt, or is found back of the sternum. The displaced clavicle may press upon the trachea, the œsophagus, or the great vessels, inducing dyspnœa, dysphagia, obliteration of pulse in the arm of the injured side, or great venous congestion of the head (see Pick). To treat a backward dislocation, pull the shoulders backward and apply a posterior figure-of-8 bandage (Pl. 12, Fig. 5), which must be worn for three weeks. If pressure-symptoms are urgent, resect the displaced head.

Upward dislocation of the clavicle is very rare. The *cause* is indirect force which carries the shoulder downward, inward, and backward (Smith).

Symptoms and Treatment of Upward Dislocation of the Clavicle.—The chief symptom is impaired function of the arm; the shoulder passes downward and inward, the clavicular axis is altered, and the displaced head is felt. Dyspnœa may or may not exist. To treat this dislocation, put a pad

in the axilla and press the elbow to the side in order to throw the bone outward, and try to push the head into place. Apply a Desault bandage (Pl. 13, Figs. 1–3) and place a firm pad over the sterno-clavicular joint. The deformity is apt to recur, but a useful limb will nevertheless be obtained.

Dislocation of the acromial end of the clavicle is almost always upward, but it may be below the acromion. The *cause* is violent force, which, if so applied to the scapula as to drive the shoulder forward, may produce a dislocation upward. A dislocation downward is due to blows upon the upper surface of the outer end of the clavicle.

Symptoms and Treatment.—The symptoms of dislocation of the acromial end of the clavicle are—prominence of the clavicle upon the top of the acromion; impaired function of the arm (cannot be lifted over the head); the shoulder falls downward and passes inward; there is apparent lengthening of the arm; the head is bent toward the injured side, and the clavicular origin of the trapezius is strongly outlined (Pick). In dislocation downward both the acromion and the coracoid are very prominent, the clavicular axis is altered, and there is depression over the sterno-clavicular joint. A dislocation upward is reduced by pulling the shoulder back and pushing the bone into place. Apply a Desault bandage, which must be kept on for three weeks. More or less deformity is inevitable. Dislocation downward is reduced and treated the same as dislocation upward.

Dislocation of the lower angle of the scapula is not, as it was long thought to be, a dislocation at all. The lower angle and vertebral border deviate from the chest. This condition was thought to be due to the bone slipping from under the latissimus dorsi muscle, but it is now known to be due to paralysis of the serratus magnus muscle, the bone being acted upon by the trapezius, pectoralis minor, levator anguli scapulæ, and rhomboid muscles. Examina-

tion shows that the scapula will not rotate normally forward. This is demonstrated by extending the arms in front to a right angle, the gliding forward of the scapula upon the sound side being marked and upon the diseased side being slight or absent.

Treatment of dislocation of the lower angle of the scapula comprises massage, electricity, passive motion, and deep injections of strychnine.

Dislocations of the Humerus (Shoulder-joint).—These injuries are most frequent because of the free mobility of the shoulder-joint, its anatomical insecurity, and its exposed situation. These dislocations are rare in the very young and in the aged, being oftenest encountered in muscular young adults. Four forms of shoulder-joint dislocation exist, namely: (1) forward, inward, and downward, under the coracoid process—subcoracoid; (2) downward, forward, and inward, beneath the glenoid cavity—subglenoid; (3) backward, inward, and downward, under the spine of the scapula—subspinous; and (4) forward, inward, and upward, under the clavicle—subclavicular.

A very rare form of shoulder-joint dislocation has been described, which is known as the "supracoracoid."

Subcoracoid Luxation.—The subcoracoid variety of dislocation embraces three-fourths of all the shoulder-joint luxations. It may be caused by direct force driving the head of the humerus forward and inward, or by indirect force, such as falls upon the hand or the elbow. In this dislocation the anatomical neck of the humerus lies upon the anterior margin of the glenoid cavity, just beneath the coracoid process, and is above the tendon of the subscapularis muscle.

Subglenoid or *axillary luxation* may be produced by contraction of the great pectoral and latassimus dorsi muscles when the arm is at a right angle to the body, but it is usually due to falls upon the hand or the elbow when the arm is

raised and the head of the bone is against the lower portion of the capsule. In this dislocation the head of the bone rests upon the border of the scapula, below the tendon of the subscapularis, in front of the long head of the triceps, and above the teres muscles. Some observers hold that most dislocations of the shoulder are primarily subglenoid, the position having been altered by muscular action.

Subspinous luxation is a rare injury. Pick met with this accident in a man who, while having his hands in his pockets, fell upon the front of the point of the shoulder. The head of the bone reposes beneath the scapular spine, between the infraspinatus and teres minor muscles.

Subclavicular luxation is very rare. It is caused by the same sort of violence which produces subcoracoid luxation. The head of the bone rests upon the thorax, below the clavicle and underneath the pectoralis major muscle.

In the rare form known as the "supracoracoid" the head of the humerus rests upon the coraco-acromial ligament or upon the acromion process. The acromion or the coracoid is always fractured.

Symptoms of Dislocation of the Shoulder-joint.—Dislocation is diagnosticated by (1) pain of a sickening character; (2) flattening of the shoulder, the head of the bone having ceased to bulge out the deltoid muscle; (3) apparent projection of the acromion through sinking in of the deltoid; (4) hollow beneath the acromion, over the empty glenoid cavity, and the bone missed from its normal habitat; (5) rigidity (some movement is possible, in the direction especially of an existing deformity, but mobility is strictly limited and attempts at motion produce great pain); (6) the elbow cannot touch the side when the hand is placed upon the sound shoulder—Dugas's sign (this is due to the rotundity of the chest. In a dislocation the head of the bone is already touching the chest, and the bone, being approximately

straight, cannot touch it in two places at the same time. If the elbow can be placed against the chest with the hand on the sound shoulder, there can be no dislocation; if it cannot be so placed, there must be dislocation); and (7) finding the head of the bone in a new situation. Symptoms 1 to 5 may be grouped as Erichsen's list of signs. The form of dislocation is made out by a study of the direction of the axis of the limb, the existence and extent of lengthening or of shortening, and the situation of the head of the bone.

The following table from T. Pickering Pick's work on *Fractures and Dislocations* makes the above points clear:

	Direction of the Axis of the Limb.	*Alteration in the Length of the Limb.*	*Presence of the Head of the Bone in New Situation.*
Subcoracoid.	The elbow is carried backward and slightly away from the side.	Very slight lengthening.	The head of the bone cannot easily be felt; if it can, it is found at the upper and inner part of the axilla.
Subglenoid.	The elbow is carried away from the trunk and slightly backward.	Very considerable lengthening.	The head of the bone can easily be felt in the axilla.
Subspinous.	The elbow is raised from the side and carried forward.	Lengthening intermediate in degree between the subglenoid and the subcoracoid.	The head of the bone can be felt and be grasped beneath the spine of the scapula.
Subclavicular.	The elbow is carried outward and backward.	Shortening.	The head of the bone can readily be seen and be felt beneath the clavicle.

In a shoulder-joint dislocation the head of the bone may press upon the brachial plexus and produce pain and numbness, and sometimes a traumatic neuritis or paralysis; sometimes pressure upon the axillary vein causes intense œdema, and pressure upon the axillary artery diminishes or obliterates the pulse. The axillary vessels may be torn and the muscles may be lacerated badly. The capsule is torn and

considerable blood is usually effused. Swelling is due first to hemorrhage and secondly to inflammation. Partial dislocations sometimes, though rarely, occur. What is usually spoken of as "partial dislocation" is a condition in which the head of the humerus passes forward under the coracoid because of rupture of the long head of the biceps or because this tendon slips out of its groove, the ligaments being intact.

Diagnosis of Shoulder-joint Dislocation.—In fracture of the neck of the scapula there is prominence of the acromion and a hollow below it, a hard body being felt in the axilla; but the coracoid process descends with the head of the bone, which it does not do in dislocation. Furthermore, in fracture there is rigidity; in dislocation mobility. In fracture crepitus is present; in dislocation it is absent. In fracture the deformity is easily reduced, but it at once recurs; in dislocation the deformity is with difficulty reduced, but does not recur. In fracture the elbow can be made to touch the side when the hand is upon the sound shoulder; in dislocation it cannot be so manipulated. In fracture of the anatomical neck of the humerus deformity is slight; the head of the humerus is found in place, and does not move when the shaft is rotated; and the head is not in line with the axis of the bone. Crepitus exists in fracture if impaction is absent. In paralysis of the deltoid there is distinct flattening, but the bone is felt in place and there is no rigidity.

Treatment of Shoulder-joint Dislocation.—Reduction by manipulation is usually readily obtained in recent cases of shoulder-joint dislocation. Always give ether. Forward dislocations (subcoracoid, subclavicular, and axillary) are reduced by Kocher's method (Fig. 73): Put the arm against the side, flex the forearm to a right angle with the arm, perform external rotation of the arm until the forearm is at a right angle with the body, raise the elbow, make internal rotation, and place the hand on the opposite shoulder. The formula

is, flexion of the forearm, external rotation, abduction, and internal circumduction of the arm. If in trying Kocher's plan external rotation of the humerus does not take place, abandon the method. Another method of manipulation is as follows: If the *right* shoulder is dislocated, the surgeon stands behind the patient (whose shoulders are raised); if the *left* shoulder is dislocated, he stands in front of the patient. The surgeon holds the arm flexed upon the forearm with his right hand and makes external traction and rotation, and with the fingers of his left hand he tries to force the bone into place.

In Henry H. Smith's method for forward dislocations the surgeon stands in front of the patient. If the *left* shoulder is dislocated, the surgeon grasps it with his left hand; if the *right* shoulder is dislocated, he grasps it with his right hand, the thumb resting on the head of the bone. With his disengaged hand the surgeon grasps the elbow, abducts it, makes traction and external rotation, and suddenly sweeps the elbow inward, aiming it at the sternum, and tries with his thumb to push the bone into place. In subspinous luxations the surgeon stands behind the patient, makes abduction, traction, and internal rotation, sweeps the elbow inward toward the spine, and with the thumb aids the bone in its return into position. Raising the elbow far above the head and sweeping it inward will reduce some dislocations. As the head of the bone slips back a distinct jar is felt and a snap is heard, the motions of the joint are again obtainable, and with the hand on the opposite shoulder the elbow may be made to touch the side.

Reduction by Extension.—In reduction of shoulder-joint dislocation by extension the patient is anæsthetized and placed upon a low bed or upon the floor. The surgeon then places his foot, covered only by a stocking, in the axilla. Place the sole of the foot, not the heel, against the chest

high up, the instep being made to touch the humerus and the heel the border of the shoulder-blade, a towel being first put into the axilla to rest the foot against (Fig. 70). If the left arm is dislocated, use the left foot, or *vice versâ*. The elder Gross approved of sitting between the patient's limbs. Make steady extension, which will in many cases bring about the reduction. If it fails to cause reduction, bring the patient's arm across the chest and use the foot as the fulcrum of a lever. If the humerus is pretty firmly fixed in its abnormal position, make counter-extension with a foot in the axilla and make extension by fixing a clove-hitch (Fig. 68) *above the elbow* and fastening to it bands which go over one shoulder and under the other shoulder of the surgeon. The back may be used for extension, the hands being left free for manipulation (Allis's and Pick's plan).

The late Prof. Pancoast favored Sir Astley Cooper's method of placing the unanæsthetized patient in a chair and using the knee as a fulcrum, pushing the elbow to the side (Fig. 69). A good method is that in which the surgeon stands behind the patient, steadies the scapula with his foot or hand, and carries the patient's arm above his head, making extension and external rotation (Fig. 71). Cock advises, when reduction fails, that an air-pad be placed in the axilla and the arm be bound to the side—a method by which reduction will often take place after two or three days. The pulleys are very rarely used, as they develop a dangerous force, antiseptic incision being a safer and a better expedient. If the pulleys are used, break up adhesions by repeated and forcible movements; fix the scapula by a collar and band fastened to the wall; attach the pulleys by one end to a clove-hitch fastened above the elbow, and by the other end to the wall; extension is made until the head of the bone moves, whereupon attempts are made to push and manipulate it into the glenoid cavity (Fig. 72).

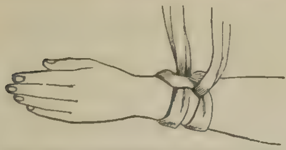


FIG. 68.—Clove-hitch Knot applied above the Wrist (after Erichsen).

FIG. 69.—Reduction of Shoulder-joint Dislocation by the Knee in the Axilla (Cooper).

FIG. 70.—Reduction of Shoulder-joint Dislocation by the Foot in the Axilla (Cooper).

FIG. 71.—Reduction of Shoulder-joint Dislocation by Extension Upward (Cooper).

FIG. 72.—Reduction of Shoulder-joint Dislocation by the Pulleys (Cooper).

FIG. 73.—Kocher's Method of Reduction by Manipulation (Ceppi): A, first movement, outward rotation; B, second movement, elevation of elbow; C, third movement, inward rotation and lowering of the elbow.

In reducing a dislocation the axillary artery or vein may be ruptured, fracture of the neck of the humerus may take place, injury to the brachial artery may occur, or the soft parts may be badly damaged. After reducing a dislocation, apply a Velpeau bandage, keep the shoulder immobile for one week, then make passive motion daily; the patient may wear a sling alone during the third week, after which period he may use the arm. (For old dislocations and compound dislocations see page 435). Reduction of old dislocations may sometimes be effected by manipulation. Extension may have to be used, and ether may be required. In old dislocations try to reduce, after breaking up adhesions, by forced flexion and strong extension. After reduction immobilize for three weeks, and start passive motion after seven days.

Dislocations of the Elbow-joint.—Injuries of the elbow-joint are not rare, and they are commonest in children. Both bones or only one bone may be dislocated, and the dislocation may be partial or be complete.

Dislocation of Both Bones Backward.—The *causes* of backward dislocation of both bones of the elbow-joint are falls upon the extended hand or twists inward of the ulna (Malgaigne). The coronoid process lodges in the olecranon fossa.

Symptoms of Backward Dislocation.—In complete dislocation of both bones of the elbow-joint the olecranon is very prominent; the distance between the point of the olecranon and the apex of the inner condyle is notably greater than on the sound side; the forearm is flexed, supinated, and shortened; the lower end of the humerus projects in front of the joint, below the skin-crease; the head of the radius is found back of the outer condyle; and there are the general symptoms of dislocation. Fracture of the coronoid rarely occurs with backward dislocation, but if it does occur there will be crepitus and mobility. In fracture

above the condyles there are found the ordinary symptoms of a fracture; measurement from condyles to styloid processes does not show shortening; there is no alteration of normal relation between olecranon process and condyles; and the projection in front of the joint is above the crease of the bend of the elbow.

Treatment of Backward Dislocation.—Reduction must be made early in dislocation of both bones of the elbow-joint, or it will be found impossible, and an unreduced dislocation means a limb without the powers of flexion, pronation, and supination. The surgeon places his knee in front of the elbow-joint, grasps the patient's wrist, presses upon the radius and ulna with his knee, and bends the forearm with considerable force, the muscles pulling the bones into place (Sir Astley Cooper's plan). Forced flexion, traction, and extension may be tried (Fig. 74). Apply an anterior angular splint, and have it worn for two weeks. Make passive motion after a few days.

Dislocation of Both Bones Forward.—The *cause* of forward dislocation of both bones of the elbow-joint is a blow on the olecranon when the arm is flexed. It is a rare accident.

Symptoms and Treatment.—The symptoms of forward dislocation of both bones of the elbow-joint are—forearm is flexed and lengthened; some slight motion is possible; olecranon is on a level with the condyles if unfractured, hence its prominence is gone; the humeral condyles are felt posteriorly, and the radius and ulna are felt anteriorly. The *treatment* of this injury is the same as that for dislocation backward. Forced flexion and pressure may be employed for reduction.

Lateral dislocations of both bones of the elbow-joint are usually incomplete.

Symptoms and Treatment of Outward Dislocation.—The symptoms of outward dislocation of both bones of the

elbow-joint are—forearm is flexed, fixed, and pronated; joint is widened; the head of the radius projects externally and has a depression above it; the inner condyle projects internally and has a depression below it; the olecranon is nearer than normal to the external condyle and further than normal from the internal condyle. Reduction is effected by extension of the forearm and pressure upon the head of the radius. Apply an ascending spiral reverse bandage of the forearm, a figure-of-8 bandage of the elbow-joint, and a sling. Make passive motion after a few days. The bandages must be worn for two weeks.

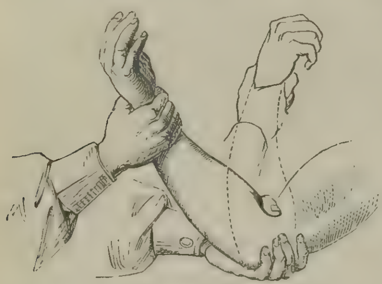


FIG. 74.—Reduction of Elbow-joint Dislocation (Tiemann).

Symptoms and Treatment of Inward Dislocation.—In dislocation inward of both bones of the elbow-joint the position of the forearm is the same as that in dislocation outward; the sigmoid cavity of the ulna projects internally, and the external condyle projects externally. The *treatment* of this form of elbow-joint dislocation is the same as that employed in the preceding form.

Dislocation of the ulna alone is very rare, and can only take place backward.

Symptoms and Treatment.—Dislocation of the ulna alone is indicated by the forearm being flexed and pronated. The head of the radius is found in place, and the olecranon projects posteriorly. The *treatment* of this injury is the same as that of the preceding dislocation.

Dislocations of the Radius Forward.—Dislocation of the radius forward is the commonest form. This injury is caused by a fall upon the hand with the forearm in pronation and

extension, or is produced by blows on the back of the joint; forced pronation alone will not cause it.

Symptoms and Treatment.—The symptoms in dislocation of the radius forward are—forearm midway between pronation and supination, and semiflexed; attempts to increase flexion cause the radius to strike against the humerus with a distinct blow; the head of the radius is felt in front of the outer condyle and is missed from its proper abode. Reduction is effected by extension and manipulation. A splint is used as in dislocation of both bones. Deformity is apt to recur after reduction, because of rupture of the orbicular ligament.

Dislocation of the radius backward is caused by falls on the hand or by blows on the front of the joint.

Symptoms and Treatment.—Backward dislocation of the radius is indicated by the forearm being slightly flexed and fixed in pronation, by some impairment of flexion and extension, and by the radius being felt behind the outer condyle. The *treatment* in this injury is the same as that given in the preceding dislocation.

Dislocation of the radius outward is very rare. In this injury the head of the radius is distinctly felt. The *treatment* is the same as that of the above-mentioned dislocations.

Subluxation of the Head of the Radius.—This name is given to an injury which is very frequent in children between two and four years of age. It results from traction upon the hand or the forearm, and often arises when the nurse or the mother pulls upon a child's arm to save it from a fall or to lift it over a gutter. Some writers hold that pronation is required, as well as extension, to produce the injury; many surgeons claim that extension and adduction are the causative forces. Hutchinson maintains that supination may cause subluxation. Bardenheuer assigned falls as causes.

The *symptoms* are very characteristic. The history points to the injury. Pain, and often a click, may be felt in the wrist at the time of the accident. The arm hangs by the side, with the elbow-joint slightly flexed and the forearm midway between pronation and supination. Flexion to a less angle than 60° and complete extension are resisted and are very painful, but movements between 60° and 130° are free and painless.[1] The movements of the wrist-joint are free and painless. The elbow-joint presents no deformity. Pressure over the head of the radius causes pain. Strong pronation is painful; strong supination is very painful, and there seems to be a mechanical obstacle to its performance. Forced supination develops a distinct click at the head of the radius, and causes pronation and supination to become natural and free from pain. The condition will be reproduced if a splint is not used. The nature of the lesion is not understood, and various conditions have been thought to exist by different observers. Among them may be mentioned the following: a slight anterior displacement of the head of the radius; a slight posterior displacement; locking of the tuberosity of the radius behind the inner edge of the ulna; dislocation of the triangular cartilage of the wrist; intracapsular fracture of the radial head; painful paralysis from nerve-injury; displacement by elongation, the return of the bone being prevented by collapse of the capsule; and the slipping up of the margin of the orbicular ligament over the rim of the head of the radius.

Treatment—Place the forearm at a right angle to the arm and make forcible supination; apply an anterior angular splint, and have it worn for four or five days.

Dislocations of the wrist, which are very rare, are caused by falls upon the hand.

[1] See the able and learned article of W. W. Van Arsdale in the *Annals of Surgery*, vol. ix., 1889.

Backward Dislocation of the Wrist.—*Symptoms.*—The deformity in backward dislocation of the wrist (Fig. 75, A) resembles that of Colles's fracture (Fig. 75, B). The fingers are flexed, the wrist is bent backward, the radius projects on the front of the wrist, the carpus projects on the dorsal surface of the arm, the relation of the styloid process of the radius to the styloid process of the ulna is unaltered (it is altered in Colles's fracture), there is rigidity, and crepitus is absent (Fig. 75).

FIG. 75.—Deformity in Dislocation of the Wrist Backward (A) and in Colle's Fracture (B) (Stimson).

Forward dislocation of the wrist, which is very unusual, is caused by a fall upon the back of the hand.

Symptoms and Treatment.—In forward dislocation of the wrist the radius and ulna project posteriorly and the carpus projects in front. The *treatment* in both of these dislocations is extension and manipulation, a Bond splint for ten days, and passive motion after five or six days.

Dislocation at the inferior radio-ulnar articulation, which is also very rare, is caused by twists.

Symptoms and Treatment.—In *forward* dislocation at the inferior radio-ulnar articulation the forearm is pronated, the space between the styloid processes is diminished, and the ulna forms a projection posteriorly. In *backward* dislocation the forearm is supinated, the space between the styloid processes is diminished, and the ulna projects in front. The *treatment* is extension and manipulation. Two straight splints (as in fracture of both bones) are to be applied for four weeks, and passive motion is to be made in the third week.

Dislocation of Individual Carpal Bones.—Pick says there is one weak spot, which is "between the head of the os magnum and the scaphoid and semilunar bones," and the os magnum may be forced up. The os magnum is the only bone dislocated with any frequency, and the injury is caused by forced flexion of the wrist.

Symptoms and Treatment.—The symptom of dislocation of the carpal bones is a firm projection which becomes more prominent during flexion of the wrist. The *treatment* is extension and manipulation, a Bond splint being worn for three weeks.

Dislocations of metacarpal bones are rare. The first metacarpal bone is most liable to dislocation.

Symptoms and Treatment.—Dislocations of the metacarpal bones are obvious because of projection. The *treatment* is extension and manipulation, a straight splint and large pad for the palm (as in fracture of the metacarpus), the splint to be worn for three weeks.

Dislocations at the metacarpo-phalangeal articulations are rare, and backward dislocation is the rule. The *cause* is a fall upon the hand.

Symptoms and Treatment.—Dislocated metacarpo-phalangeal articulations are obvious. Reduction is easily effected, except in the case of the thumb. A splint must be worn for three weeks.

Dislocation of the Metacarpo-phalangeal Joint of the Thumb.—In this dislocation the phalanx usually passes backward.

Symptoms.—Symptoms of *backward* dislocation are—the base of the first phalanx rests upon the metacarpal bone; the head of the metacarpal bone projects forward and button-holes the muscles of the thumb; the first phalanx of the thumb is strongly extended, and the terminal phalanx is semiflexed. The symptoms of *forward* dislocation are—the

base of the first phalanx is felt in the palm, and the head of the metacarpal bone is felt posteriorly.

Treatment.—In treating backward dislocation of the metacarpo-phalangeal joint of the thumb, reduction is difficult because of the head of the bone being caught in the perforation of the flexor muscle. Always give ether. Keetley's directions are to adduct the metacarpal bone into the palm (to relax the muscles) and to have an assistant hold it; bend the thumb strongly back, extend, pull the thumb

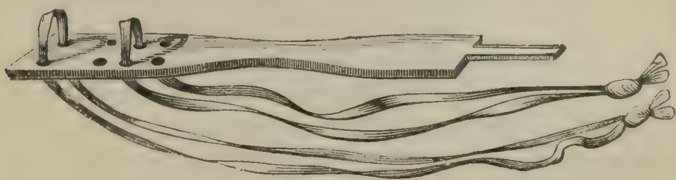


FIG. 76.—Levis Splint for Reducing Dislocation of Phalanges.

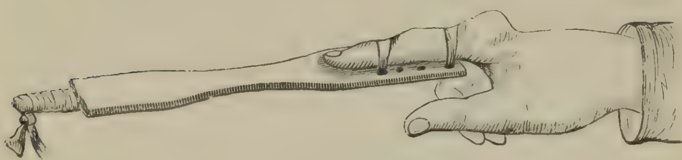


FIG. 77.—Levis Splint Applied.

toward the fingers, and suddenly flex. To get a firm enough grasp for these manipulations, use the apparatus of Charriere or of Levis (Figs. 76, 77). If the above manœuvres fail, perform tenotomy or incise freely and reduce. After reduction of this dislocation a splint must be worn for three weeks. In forward dislocation reduction is easily effected by strong extension and forced flexion. A splint is to be worn for three weeks.

Dislocations of the phalanges may be complete or may be partial. They are commonest between the first and second phalanges.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. In treating such dislocations, employ extension and manipulation, and a splint for one week.

Dislocations of the Ribs and Costal Cartilages.—The ribs may be dislocated from the vertebræ. This accident is rarely uncomplicated, and cannot be differentiated from fracture. The diagnosis is rarely made, and the injury is treated as a fracture. The ribs may be dislocated from their cartilages, one or more ribs being displaced. The end of the rib forms an anterior projection, there is a depression over the cartilage, and crepitus is absent. *Treatment* is the same as that employed for fractured ribs. The costal cartilages may be displaced from the sternum, forming an anterior projection upon this bone. Reduction is brought about by placing the patient upon a table with a sand pillow between the scapulæ, pushing back the shoulders and chest, and forcing the cartilage into place. The dressings are the same as those used in fractured sternum. The cartilages of the lower ribs (sixth, seventh, eighth, ninth, and tenth) may be separated. The inferior cartilage goes forward and can be felt. Pick states that reduction is brought about by causing the patient to hold the chest full of air while efforts are made to push the cartilage into place. Dress as for fractured ribs.

Dislocations of the Sternum.—In dislocations of the sternum the manubrium may be separated from the gladiolus in young subjects. The *symptoms* and *treatment* are the same as those in fracture (p. 342).

Pelvic dislocations are almost always complicated with fracture. A pubic bone can be dislocated by falls from a height or by applying violent force to the acetabula. The dislocation may be up or down, front or back, and it may damage the urethra or the bladder. The patient cannot stand; there are great pain and recognizable deformity. Treat by moulding the bones into place, by applying a pelvic belt,

and by rest in bed for four weeks. Dislocations of the sacro-iliac joint are produced by falls. Movement on the part of the patient is difficult or impossible; there is violent pain, and often paralysis (from pressure upon nerves). In dislocation backward there is an apparent shortening of the leg, eversion of the foot exists, and the ilium moves posteriorly and upward. In dislocation forward the anterior superior iliac spine projects and the pelvis is broadened. Sacro-iliac dislocations are reduced by holding the pelvis firm and making extension with a pulley. The patient stays in bed for four weeks and wears a pelvic belt as in fracture.

Dislocations of the Femur (Hip-joint).—These injuries are rare, as the hip-joint is very strong. They occur in young adults. In forcible extension the head of the femur presses against the capsule, but the capsule here is very thick, and certain muscles, the rectus, psoas, and iliacus, are pulled tight and serve to strengthen the capsule. The head of the bone cannot go directly upward, because of the acetabulum (Edmund Owen). The weak point of the acetabular rim is below; the weak part of the capsule is also below; hence forced abduction is apt to take the head of the bone through the lower part of the capsule, a dislocation occurring primarily into the thyroid foramen. Four forms of hip-joint dislocation exist: (1) upward and backward, on the dorsum of the ilium; (2) backward, into the sciatic notch; (3) downward, into the obturator foramen; and (4) inward, on the pubes.

Dislocation on to the dorsum of the ilium comprises one-half of all hip-dislocations. It is *caused* by a fall or a blow when the limb is flexed and abducted (as in carrying a weight upon the shoulder), by a fall upon the knees or feet, by a weight striking the back while bending, etc. In this dislocation the head of the femur goes upward and backward, rests upon the ilium, and is always above the tendon

of the obturator internus muscle. This dislocation is secondary to a thyroid dislocation, because of muscular action shifting the bone from its initial seat of displacement.

Symptoms.—Dislocation on to the dorsum of the ilium is indicated by the following symptoms: The buttock looks flat and broad; the great trochanter is above Nélaton's line and is deeply placed; the head of the bone can be detected in its new situation; deep pressure in front of the joint finds a hollow; the leg is shortened by about two or three inches, as a rule; the knee is slightly flexed; the thigh is slightly flexed, inwardly rotated, and adducted (Fig. 78) (this is shown by the fact that the axis of the thigh of the injured side, if prolonged, would pass through the lower third of the sound thigh); the heel is raised, and the great toe of the foot of the injured side rests upon the front of the instep or the ankle of the sound side; the fascia lata is relaxed; rigidity exists; voluntary movement is impossible, though some passive motion is possible in the direction of the deformity (the deformity can be made more marked).

The *diagnosis* from intracapsular fracture is obtained by noting the inversion, the great shortening, the absence of crepitus, the age of the subject, and the nature of the force. The nature of the force, the inversion, and the absence of crepitus mark the diagnosis from extracapsular fracture.

Treatment.—The chief obstacle to reduction in dislocation on to the dorsum of the ilium, Bigelow states, is the untorn portion of the capsule, especially the Y-ligament. The ilio-femoral, Y, or Bigelow's ligament resembles an inverted Y, arises from the anterior inferior spine of the ilium, is inserted into the anterior intertrochanteric line, and is incorporated into the front of the capsule. To reduce a dislocation this ligament must be relaxed by manipulation or be torn by extension. Manipulation makes the head of the bone retrace its steps over the same route it took in emerging. Give

Fig. 78.—Hip-joint Dislocation: Upward, or on the dorsum of the ilium (Cooper).

Fig. 79.—Reduction of Dislocation on the Dorsum of the Ilium by the Pulleys (Cooper).

Fig. 81.—Reduction of Dislocation into the Sciatic Notch by the Pulleys (Cooper).

Fig. 80.—Hip-joint Dislocation: Backward, or into the sciatic notch (Cooper).

Fig. 82.—Hip-joint Dislocation: Downward, into the obturator or thyroid foramen (Cooper).

Fig. 83.—Reduction of Dislocation into the Obturator Foramen by the Pulleys (Cooper).

Fig. 84.—Dislocation on the Pubes (Cooper).

Fig. 85.—Reduction of Dislocation on the Pubes by the Pulleys (Cooper).

ether; place the patient supine upon a mattress on the floor; flex the leg on the thigh (to relax the hamstrings), the thigh on the pelvis; increase the adduction over the middle line; strongly abduct; perform external rotation and extension. This treatment may be summed up as flexion, adduction, external cirumduction, and extension; or, as Pick puts it, "bend up, roll out, turn out, and extend." If manipulation fails, try extension. A perineal band is fastened to the wall, and extension by pulleys is made in the axis of the deformed limb—that is, across the lower third of the other thigh (Fig. 79), or at a right angle to the body while the patient lies upon the sound side. After reduction put the patient to bed and use sand-bags (as in fracture of the hip) for four weeks. Passive motion is made in the third week.

Dislocation into the Sciatic Notch.—In this dislocation the head of the bone passes backward and a little upward, and rests upon the ischium at the margin of the sciatic notch (not in the notch), below the tendon of the obturator internus muscle. The *causes* are the same as those given for the previous dislocation.

Symptoms.—The signs in dislocation into the sciatic notch are like those of dislocation upon the dorsum of the ilium, but they are not so marked. There are flattening and broadening of the hip; ascent of the trochanter above Nélaton's line; shortening to the extent of an inch. Flexion, inward rotation, and adduction exist, but the axis of the femur of the injured side passes through the knee of the sound side, and the ball of the great toe of the injured side rests upon the great toe of the sound side (Fig. 80). Other symptoms are identical with dislocation upon the dorsum of the ilium, but are less pronounced. Allis's signs of this dislocation are of value: if, with the patient recumbent, the thighs are brought to a right angle with the body,

shortening on the affected side is materially increased; if the dislocated thigh is extended, the back arches as in hip disease.

Diagnosis and Treatment.—The symptoms of dislocation into the sciatic notch are similar to, but are less marked than, those of dorsal dislocation, and, being a backward dislocation, the reduction and treatment are the same as for dislocation backward upon the dorsum of the ilium (Fig. 81).

Dislocation Downward into the Obturator Foramen.—Downward dislocation is the primary position of most dislocations of the hip, the bone rarely remaining in the thyroid foramen, but usually mounting up as a result of muscular action or of the initial violence. The *cause* is violent abduction by falls or by stepping from a moving car.

Symptoms.—Dislocation downward into the obturator foramen is indicated by flattening of the hip; the head of the bone is felt in its new position and is missed from the acetabulum; rigidity except in the direction of deformity; a hollow over the great trochanter, which process is well below Nélaton's line and nearer than normal to the middle line; the gluteal crease is lower than is the crease of the opposite side; lengthening to the extent of one to two inches; the body is bent forward by the traction upon the psoas and iliacus muscles, and is also deviated to the side, thus causing great apparent lengthening; the limb is advanced and abducted, and the foot is pointed straight ahead or is a little everted (Fig. 82); when the patient is recumbent extension is impossible, the knees cannot be pushed together without great pain, and the adductor muscles are hard and rigid. Unreduced dislocations do well, the patient obtaining a very useful hip-joint (Sédillot).

Treatment.—In treating dislocation downward into the obturator foramen, effect reduction if possible by manipulation, and if this fails by extension. To reduce by manipulation, flex the leg on the thigh and the thigh on the pelvis, and then perform, in the following order, abduction, internal

circumduction, and extension. If extension is used, employ a pelvic band to pull the pelvis toward the sound side, and a perineal band beneath the pelvic band, having pulleys to maintain force upward and outward from the injured hip. The surgeon, grasping the leg and ankle, drags the member inward and pries the femur into place (Keetley; Fig. 83). The after-treatment is the same as that for the previous forms.

Dislocation into the pubes is very rare. The head of the bone usually rests just internal to the anterior inferior spine of the ilium. The primary position of the bone is in the thyroid foramen; the pubic dislocation, when it occurs, is always secondary, and is due to the initial force and to muscular action.

Symptoms.—In pubic dislocation the head of the bone can be felt and seen in its new position; the hip is flattened; there is a hollow over the great trochanter, this process being found below the anterior superior spine of the ilium; there is shortening to the extent of an inch; the limb is in abduction with eversion (Fig. 84), and the knees cannot be approximated without great pain.

Treatment.—The treatment of pubic dislocation is manipulation as performed for thyroid dislocation. If this fails, employ extension. The limb is well abducted, extension is made downward and backward, and the head of the femur is pulled outward "by a towel around the thigh, just beneath the groin" (Keetley; Fig. 85). The after-treatment is the same as that for the previous forms.

Anomalous Dislocations of the Hip.—In *supraspinous dislocation* the dislocation of the hip is backward, the head of the femur resting upon the ilium above or even anterior to the anterior superior spine. In *ischial dislocation* the dislocation is downward and backward, the head of the femur resting on the ischial tuberosity or in the lesser sciatic notch. *Monteggia's dislocation* is a supraspinous dislocation with

eversion of the limb. In *perineal dislocation* the head of the femur is in the perineum. In *suprapubic dislocation* the head of the femur passes above the pubes. In *subspinous dislocation* the femoral head rests on the horizontal ramus of the pubes.

Dislocations of the Knee.—These dislocations are rare. There are four forms—forward, backward, inward, and outward. They may be complete or be incomplete; the commonest dislocations are lateral. The *cause* is violent force, such as a fall, or in jumping from a moving train, or in being caught by the foot and dragged.

Dislocation Forward of the Knee-joint.—In the *complete* form of forward dislocation the deformity is obvious. The limb is usually extended, but it may be flexed. Much shortening exists; the condyles are felt posterior and below; the head of the tibia is felt anterior and above; the patella is movable and the quadriceps is lax; pressure of the condyles upon the contents of the popliteal space stops the tibial pulse and causes œdema and intense pain. In *incomplete* dislocation the symptoms are identical in kind, but are less pronounced.

Treatment.—Compound dislocation of the knee-joint often demands excision or amputation. In simple dislocation give ether. One assistant extends the leg, another makes counter-extension on the thigh, and the surgeon pushes the bone into place. Reduction is easy because of ligamentous laceration. Place the limb on a double inclined plane, and combat inflammation by the usual methods (see *Synovitis*, p. 395). Begin passive motion in the third week. The patient must wear a knee-support for months. If the popliteal vessels are much damaged, gangrene will supervene and amputation will be demanded.

Dislocation Backward of the Knee-joint.—In the *complete* form of knee-joint dislocation backward displacement

is not so great as in dislocation forward. The head of the tibia projects posteriorly and above, the femoral condyles anteriorly and below; the leg is, as a rule, partly flexed, but it may be extended, and there is moderate shortening. In *incomplete* dislocation the symptoms are less marked.

Treatment.—The treatment of backward dislocation of the knee-joint is the same as for forward dislocation.

Dislocation Outward of the Knee-joint.—The inner tuberosity of the tibia in outward dislocation lies upon the outer condyle of the femur (Pick); the inner condyle of the femur projects internally; the outer tibial tuberosity and fibular head project externally, the former having a depression below it, and the latter above it; the leg is semiflexed, but shortening is absent.

Dislocation Inward of the Knee-joint.—The outer tuberosity of the tibia in inward dislocation lies upon the inner condyle of the femur; the outer condyle of the femur forms an external prominence, and the inner tuberosity of the tibia forms an internal prominence. Pick cautions us not to mistake a separation of the lower femoral epiphysis for lateral dislocation (the former is reduced easily, the deformity tends to recur, and there is soft crepitus).

Treatment.—In treating lateral dislocation of the knee-joint, effect extension and counter-extension as in antero-posterior dislocations. The leg is moved from side to side and attempts are made at rotation. The after-treatment is the same as that for antero-posterior luxations.

Lateral dislocations of the knee-joint are usually incomplete.

Dislocation of the Semilunar Cartilages of the Knee (the Internal Derangement of Mr. Hey; Subluxation).—These interarticular cartilages are attached in front of and behind the tibial spine, and their convexity is attached to the edge of the tibial tuberosities by the coronary ligament. The

inner cartilage is connected with the internal lateral ligament, and it has a moderate freedom of movement; the outer cartilage is not connected with the external lateral ligament, and is not freely movable, yet the outer is more often dislocated than is the inner cartilage. The *cause* is a twist when the knee is flexed, as in stubbing the toe.

Symptoms.—The indications of interarticular-cartilage dislocation are a sudden violent, sickening pain in the knee, that may cause the patient to fall; the position is one of fixed semiflexion, voluntary motion being impossible and passive motion causing fierce pain; a displacement of either cartilage away from the tibial spine produces a prominence on one or the other side of the knee-joint, and a displacement toward the tibial spine makes a prominence on one side of the ligament of the patella. Subluxation is soon followed by inflammation, and swelling rapidly masks the projection. This accident is usually mistaken for blocking of a joint by a floating cartilage.

Treatment.—In treating dislocation of the semilunar cartilages of the knee, reduce by forced flexion and sudden extension with rotation, at the same time endeavoring to push the projecting cartilage into place. After reduction combat inflammation, apply a splint, and use the proper remedies for one week (see *Synovitis*), then begin passive motion. As recurrence of the displacement is usual, the patient should wear a knee-cap for a year or more. If reduction is impossible, persistent passive motion will secure a useful joint.

Dislocations of the Fibula: Dislocation at the Superior Tibio-fibular Articulation.—This injury is rare. The head of the fibula may go forward or backward. The *causes* are direct force and violent adduction of the foot with abduction of the knee (Bryant).

Symptoms.—In dislocation of the fibula the position is one of semiflexion, voluntary extension and flexion being

impaired or lost. A distinct movable projection is readily noticed in front or behind, which is found to be continuous with the fibula. There is a depression over the normal position of the head of the fibula.

Treatment.—In treating dislocation of the fibula, bend the knee to relax the biceps, and proceed to push the bone into place. Put a compress over the head of the fibula, apply a bandage, and put the limb on a double inclined plane for three weeks. At the end of this time put a lacing knee-support upon the knee and let the patient up. Displacement being liable to recur, a knee-cap must be worn for a year.

Dislocations of the Ankle-joint.—These injuries are not unusual. Fracture is a frequent complication. There are five forms of ankle-joint dislocation—outward, inward, forward, backward, and upward.

Lateral dislocations of the ankle-joint are either outward and inward, and may be complete or incomplete. In these dislocations the astragalus rotates. In incomplete dislocations "there is no great separation of the trochlear surface of the astragalus from the under surface of the tibia, but the outer or inner margin of this surface is brought into contact with the articular surface of the tibia, and the whole foot presents a lateral twist" (Pick). The *causes* of these dislocations are twists of the joint.

Symptoms.—Incomplete outward dislocation of the ankle-joint is known as *Pott's fracture* (see p. 391), and complete outward dislocation, in which the articular surface of the astragalus is completely displaced from the articular surface of the tibia, is known as *Dupuytren's fracture.* In incomplete dislocation the foot goes outward and upward, the fibula is fractured, and the tibio-fibular ligaments are torn off. In Dupuytren's fracture the ankle is broad, the inner malleolus projects and looks lower than natural, the outer malleolus ascends with the foot, the foot rotates outward,

and crepitus can be found. In inward dislocation which is associated with fracture of the inner malleolus there is inversion, the outer malleolus projects, and crepitus can be found. In incomplete separation the symptoms are similar, but are not so marked.

Treatment.—In treating outward dislocation of the ankle-joint the deformity is reduced by flexing the leg on the thigh and the thigh on the pelvis; an assistant makes counter-extension from the knee; the surgeon makes extension from the foot, and at the same time rocks the astragalus into place. Dupuytren's fracture is treated in the same manner as Pott's fracture (p. 391). Dislocation inward is treated in a fracture-box for the same period as Pott's fracture.

Antero-posterior dislocations of the ankle-joint are rare. The *cause* is the catching of the foot in jumping or falling—direct violence. In dislocation forward the foot is lengthened, the heel is not conspicuous, the tibia and fibula project against the tendo Achillis, and the relation of the malleoli to the tarsus is altered. In incomplete dislocation the symptoms are similar, but less pronounced. In dislocation backward the foot is shortened, the tibia and fibula project in front, the heel is prominent, and the relation between the malleoli and the tarsus is altered. In incomplete dislocation the symptoms are similar, but less marked.

Treatment.—In antero-posterior dislocation of the ankle-joint, reduce as in lateral dislocations. Sometimes the tendo Achillis must be cut. Apply a silicate-of-soda dressing, and let it be worn for two weeks; then begin passive motion, and let the patient wear side-splints for a week longer.

Dislocation upward of the ankle-joint is a very rare injury. The astragalus wedges in between the widely-separated tibia and fibula. This dislocation is usually associated

with fracture. The *cause* is a fall upon the feet from a great height.

Symptoms.—Upward dislocation of the ankle-joint is indicated by the widening of the ankle and by the flattening of the foot. The malleoli are nearly on a level with the plantar surface of the foot, and there is absolute rigidity.

Treatment.—In treating upward dislocation of the ankle-joint, give ether and try to reduce by powerful extension and counter-extension. Treat the injury afterward as in antero-posterior luxation.

Dislocation of the Astragalus.—The astragalus may be displaced from the bones of the leg and at the same time be separated from the rest of the tarsus. The displacement may be forward, backward, outward, inward, or rotary.

Dislocation of the astragalus forward or backward is caused by falls or twists.

Symptoms.—In forward dislocation the astragalus projects strongly; there is shortening of the foot, and the malleoli approach the plantar aspect of the foot; the foot is deviated to one side or to the other, and there is absolute rigidity of the ankle-joint. In incomplete luxations the symptoms are similar, but less marked. This dislocation may be obliquely forward. In backward dislocation of the astragalus the foot is not deviated to either side; the astragalus projects between the malleoli and above the os calcis, and the tendo Achillis is stretched over the projection. Rigidity is absolute. This dislocation may be obliquely backward.

Lateral and Rotary Dislocations of the Astragalus.—Lateral dislocations of the astragalus are rare, are always compound, and are always associated with fracture. In rotary dislocation the astragalus remains in its normal habitat after rotating on its own axis, either horizontal or vertical. The *causes* of rotary dislocation are twists of the foot when at a right angle to the leg (Barwell). The *symp-*

toms of rotary dislocation are obscure. There is rigidity, but sometimes portions of the astragalus may be made out.

Treatment of Dislocations of the Astragalus.—In treating astragalus dislocation, reduce under ether by flexing the knee to relax the gastrocnemius, extending the foot, and pushing the bone into place. It may be necessary to cut the tendo Achillis. After reduction put up the foot and leg in silicate-of-soda dressing for two weeks, and then begin passive motion and apply side-splints, which are to be worn for one week more. If reduction fails, support the limb on splints, combat inflammation, and endeavor to bring about union between the dislocated bone and the tissues. Often, in unreduced dislocation, the skin sloughs over the projecting bone. Excision is demanded the moment sloughing is seen to be inevitable. Cases of compound dislocation of the astragalus require immediate excision.

Subastragaloid Dislocation.—This condition is a separation of the astragalus from the os calcis and scaphoid, without separation of the astragalus from the bones of the leg. Pick states that the usual classification for these dislocations is forward, backward, inward, and outward, but that the displacement is, as a rule, oblique, the foot passing backward and outward or backward and inward. The *causes* are twists.

Symptoms.—In subastragaloid dislocation the astragalus projects on the dorsum; the foot is everted in outward dislocation and inverted in inward dislocation; the relation of the malleoli to the astragalus is unaltered; the ankle-joint is not absolutely rigid; the foot "is shortened in front and is elongated behind" (Pick).

Treatment.—To treat subastragaloid dislocation, make extension in the direction opposite to that of the displacement. In dislocation of the tarsus backward, fix a bandage around the foot, on a level with the heads of the metatarsal bones, which bandage the surgeon ties around his shoulders.

The surgeon puts one knee in front of the ankle and thus fixes the leg, raises himself up to make extension upon the tarsus, and moulds the bone into position. Tenotomy may be necessary. After reduction apply a silicate dressing for three weeks. The ankle-joint, fortunately, is not involved, and stiffness of this articulation need not be apprehended. If reduction is impossible, take the same course as in luxations of the astragalus.

Dislocations of the other tarsal bones are very rare. Single bones may be dislocated, or the luxation may occur at the medio-tarsal articulation.

Symptoms and Treatment.—Projection is an obvious symptom in dislocation of the other tarsal bones. The *treatment* is to reduce by extension and moulding, the part being put up in silicate-of-soda dressing for two weeks.

Dislocations of the metatarsal bones are rare.

Symptoms and Treatment.—Shortening of the toes and projection of the dislocated bone are symptoms of dislocation of the metatarsal bones. To *treat* these dislocations, reduce by extension under ether and put up in a silicate dressing for two weeks. If reduction fails, the functions of the foot will not be much impaired.

Dislocations of the phalanges are very rare. The first phalanx of the big toe is the one most liable to dislocation.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. The *treatment* is by reduction as in dislocations of the thumb. Immobilize for two weeks.

5. Operations upon Bones.

Osteotomy.—By the term *osteotomy* the modern surgeon means literally the sectioning of a bone for the purpose of straightening a limb ankylosed in a bad position, correcting a bony deformity, or amending a vicious union of a fracture. In a *linear osteotomy* the bone is transversely divided in one

spot; in a *cuneiform osteotomy* a wedge-shaped portion of bone is removed. The operation of osteotomy may be performed with a saw (Fig. 86) or with an osteotome. The saw creates dust, draws much air into the wound, and lacerates the tissues to a considerable degree. Most surgeons prefer the chisel or the osteotome. The osteotome (Fig. 88) differs from a chisel in having two bevels instead of one.

Osteotomy for Genu Valgum, or Knock-knee (Macewen's Operation).—In this operation the instruments required are

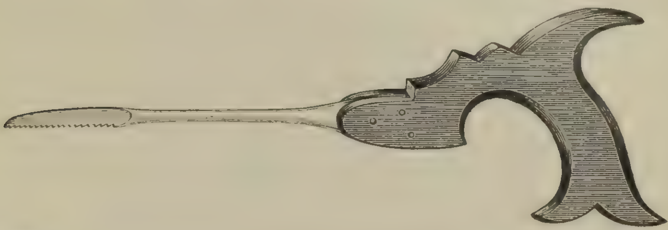


FIG. 86.—Adams's Large Saw.

FIG. 87.—Rawhide Mallet.

FIG. 88.—Osteotome.

the scalpel, hæmostatic forceps, osteotomes of several sizes, a mallet (Fig. 87), and a sand-bag wrapped in an aseptic towel.

Operation.—The patient lies upon his back, being rolled a little toward the diseased side. The leg of the diseased side is partly flexed upon the thigh and the thigh upon the pelvis, and the extremity is laid upon its outer surface, the sand-bag being pushed between the extremity and the bed, opposite to the site of section. The flexion of the knee relaxes the popliteal vessels and saves them from injury. The surgeon,

if operating on the right leg, stands outside of that extremity; if operating on the left leg, he stands opposite the left hip (Barker). Enter the knife at the inner side of the knee, just in front of the adductor tubercle of the inner condyle and on a level with the upper border of "the patellar articular surface of the femur" (Barker); cut down to the bone, and make an incision upward one inch in length, in the direction of the axis of the femur. At the lower angle of this wound insert an osteotome and turn it to a right

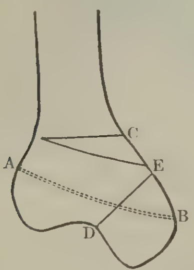


FIG. 89.—Osteotomy of the Right Femur in a Case of Knock-knee: AB, epiphyseal line; C, section of Macewen; DE, section of Ogston.

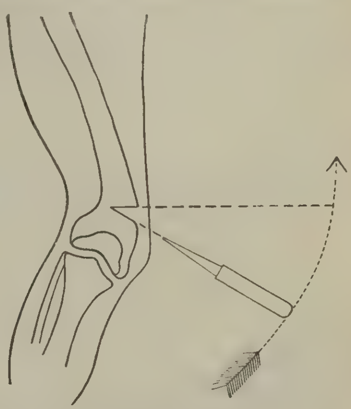


FIG. 90.—Macewen's Operation for Genu Valgum: the chisel is held in the line for striking with a mallet; the arrow shows the direction in which the chisel is levered up and down so as to make a wide gap in the bone (after Barker).

angle with the shaft, half an inch above the epiphysis (Fig. 89); strike the osteotome several times with a mallet; move the handle several times toward and from the body, so as to widen the cut in the bone (Fig. 90); strike the osteotome again several times, move it again, and continue this process until the bone is cut one-third through. If the osteotome becomes tightly fixed, withdraw it and introduce a smaller one. When the bone is cut two-thirds through, withdraw the osteotome, hold a piece of wet antiseptic gauze over the opening, and fracture the femur by strong adduction. Do

not suture nor drain the wound, but dress it antiseptically, wrap the entire extremity in cotton, and apply a plaster-of-Paris dressing up to the groin. This dressing may be removed in two weeks, and the patient may subsequently be treated with sand-bags, but without extension, as for an ordinary fracture of the thigh. This operation is scarcely ever fatal.

Ogston's Operation (Fig. 89).—In this operation the internal condyle is sawed off obliquely with an Adams saw—a proceeding which permits the straightening of the knee. The objection to this operation is that it opens the knee-joint, and that this cavity fills up more or less with a mixture of blood and bone-dust. Macewen's operation is decidedly the safer.

Osteotomy for a Bent Tibia.—In this operation the instruments required are the same as those indicated in the above operation. The tibia is divided transversely or obliquely (linear osteotomy), or a wedge-shaped piece is removed (cuneiform osteotomy). The oblique incision is the best. If the convexity of the tibial curve is inward, cut the bone from above downward and from in front backward; if the curve is forward, section the bone from above downward and from within outward. The fibula need rarely be interfered with.

Osteotomy for Faulty Ankylosis of the Hip-joint.—This operation is performed in order to allow straightening of a limb which has undergone bony ankylosis in a faulty or an inconvenient position. In some cases an attempt is made to obtain a movable joint, but in most cases the surgeon must be satisfied with an ankylosis in extension. Osteotomy may be performed through the neck of the femur or through the shaft of the femur below the trochanters.

Osteotomy through the neck of the femur is performed

(1) with a saw (Adams's operation) or (2) with an osteotome.

1. *Adams's Operation* (Fig. 91).—In this operation the instruments required are a scalpel, hæmostatic forceps, a long, blunt-pointed tenotome, and an Adams saw.

Operation.—The patient lies upon his sound hip; the surgeon stands upon the side to be operated upon, and back of the patient. The knife is entered a finger's breadth above the great trochanter, is pushed in until it strikes the neck of the bone, is then carried across the front of and at a right angle to the neck, and is withdrawn, enlarging the wound in the soft parts, as it emerges, to the extent of an inch. The saw is now introduced and the neck is entirely divided. After the osteotomy dress the wound antiseptically and place the extremity straight. To straighten the limb it may be found necessary to cut contracted tendons and fascial bands. Apply the weight-extension apparatus and the sand-bags. Begin passive movements from the start if a movable joint is desired; few patients can tolerate the pain necessary to bring this about. If it is determined to aim for a stiff joint, treat the case as an intracapsular fracture would be treated.

FIG. 91.—Osteotomy through the Neck of the Femur: A, Adams's operation; B, Gant's operation.

2. *With an Osteotome.*—The instruments required in this operation are the same as those used for genu valgum. No sand-bag is required. The position of the patient is the same as that in Adams's operation. An incision one inch long is made, starting just above the great trochanter, ascending in the axis of the femoral neck, and reaching to the bone. An osteotome is introduced, is turned to a right angle with the bone, and is struck with a mallet until the bone is *completely* divided. (It is not to be divided partially and then broken.)

The after-treatment is the same as that for Adams's operation. The operation with the osteotome is to be preferred to that by the saw.

Osteotomy of the Shaft of the Femur below the Trochanters (Gant's Operation).—In this operation (Fig. 91) the saw may be used, but the osteotome is to be preferred. The instruments employed are the same as those used for Adams's operation, plus an osteotome.

Operation.—The position in Gant's is like that in Adams's operation. A longitudinal incision one inch long is made upon the outer aspect of the femur and on a level with the lesser trochanter. The osteotome is inserted and the bone is completely divided below the lesser trochanter. The after-treatment is the same as that for Adams's operation. Gant's operation is the best method for correcting faulty position in bony ankylosis, and Adams's operation can only be employed in those cases where the femur still has a neck which practically is unchanged.

Osteotomy for Faulty Ankylosis of the Knee-joint.—This operation is performed for bony ankylosis of a knee in a position of flexion. The instruments employed are the same as those used for genu valgum.

Operation.—The patient lies upon his back with his thighs flat upon the bed, the legs hanging over the end of the bed. The surgeon stands on the patient's right side. Just above the patellar articular surface upon the femur a transverse incision is made, one inch in length and reaching to the bone. The osteotome is introduced and the bone is cut *nearly* through. The leg is then forcibly extended. Do not extend too violently, or the popliteal vessels may be injured. In cases where the structures of the popliteal space are tense, do not at once bring the leg into extension, but do so gradually by means of weights. The wound is dressed antiseptically, and the extremity is placed upon a double

inclined plane and is treated as for fracture near the knee-joint.

Osteotomy for vicious union of a fracture is performed in case of angular deformity, and is carried out in the same manner as are the above procedures. It is best, when possible, to enter the osteotome upon the concavity of the bent bone, so as not to rupture the periosteum when extension is made, and to thus enable one to gain a longer limb.

Osteotomy for Hallux Valgus.—In this operation a linear osteotomy is made through the neck of the metatarsal bone of the great toe, the toe is forcibly adducted, and a splint is applied to the inside of the foot and the toe.

Osteotomy for Talipes Equino-varus.—The instruments required in this operation are a scalpel, hæmostatic forceps, a narrow, blunt-pointed saw, special directors, bone-cutting forceps, sequestrum forceps, and scissors.

Operation (after Barker).—The patient lies upon his back, the thigh is semiflexed, the knee is bent, and the sole of the foot rests upon the table. The surgeon stands to the right side if it is the right limb operated upon, or to the left side if it is the left limb. Feel for the outer surface of the cuboid bone, and cut away from over the latter a piece of skin corresponding in size with the bone-wedge intended to be removed (this piece of skin must include the bursa which forms in these cases). Turn the foot outward, find the astragalo-scaphoid articulation, over which make an incision "from the lower to the upper dorsal border of the scaphoid bone" (Barker), reaching through the skin only; place the foot again in the first position, raise all the soft parts from off the superior surface of the tarsus, and clear a triangular surface corresponding with the base of the wedge to be removed; pass a "kite-shaped" director (Fig. 92) from the external wound, and cause it to project from the internal wound; push the saw through the groove of the director

nearest the toes, and saw through the tarsus, from the dorsum to the sole, at right angles to the metatarsal bones; push the saw through the groove of the director nearest the ankle, and saw from the dorsum to the sole, at right angles to the long axis of the calcaneum; grasp the wedge-shaped piece of bone with sequestrum forceps, and cut it out with scissors, with bone-forceps, or with a blunt bistoury. The wound is well irrigated, the foot is straightened, the internal wound is sewed up, the external wound is sutured except at its lowest portion, where a drainage-tube is to be retained for twenty-four hours, and the wound is dressed antiseptically. The foot is put up in plaster or is put upon a Davy splint.

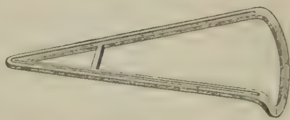


FIG. 92.—Davy's Director (Pye).

Osteotomy for Talipes Equinus.—This operation is described by Mr. Davy, who devised it, as follows:[1] "Taking the line of the transverse tarsal joint as a guide, on the outer and inner sides of the foot, and immediately over the joint, two wedge-shaped pieces of skin are removed, equal in extent to the amount of bone demanded. The soft structures are freed on the dorsum of the foot in the way previously described; but, as the base of the osseous wedge for equinus cases is at the dorsum and its apex at the sole, the parallel wire director, instead of the kite-shaped varus one, is used. The saw is successively inserted in its grooves, and by keeping in mind the idea of a keystone a clean wedge of bone is cut out from the dorsum to the sole of the foot." The wedge is extracted, and the foot is straightened and is put in plaster or in a Davy splint.

Bone-grafting, or Transplantation (see p. 303).

Osteotomy and Wiring for Ununited Fracture.—The instruments required in this operation are a scalpel, hæmo-

[1] Barker's *Manual of Surgical Operations.*

static forceps, dissecting-forceps, retractors, Allis's dissector, an awl or special drill (Figs. 93, 94), chisels, a mallet, a fine saw, lion-jaw forceps, and silver wire.

In operating, incise longitudinally down to the seat of fracture, retract the periosteum from the bone, drill the bones before cutting them, chisel away the material of imperfect union, saw through each end far enough from the seat of fracture to reach sound tissue, pass large silver wires through the holes (this wire should be one-tenth inch in diameter for the femur, one-sixteenth inch for the patella, etc.), twist the

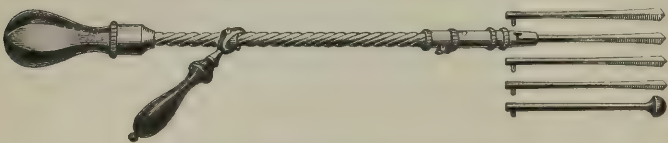


FIG. 93.—Hamilton's Improved Bone-drills.

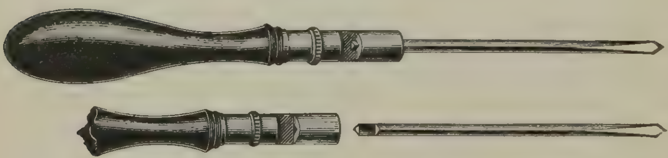


FIG. 94.—Wyeth's Drills, with Adjustable Handle.

wires a fixed number of times (two) in the direction that the hands of a watch move (this is Keen's direction in case removal of the wires should be demanded), sever the ends of the wires, and hammer their stems against the bone. The wires may never require removal. Dress the part as a recent fracture. In fracture of the patella an incision is made in the long axis of the limb, above the middle of the space between the fragments, from well above the upper fragment to well below the lower piece; this incision divides all the soft parts. The soft parts are retracted, but the periosteum is undisturbed; each fragment is bored (Fig. 95, A)

in one or two places; the surfaces of the fragments are cut square through sound bone with a saw; all old reparative material is cut away; the wires are passed through the perforation, twisted, cut off, and hammered down as before (Fig. 95, B). A small drain is inserted, the wound is sutured, antiseptic dressings are applied, and the limb is put upon a Macewen splint.

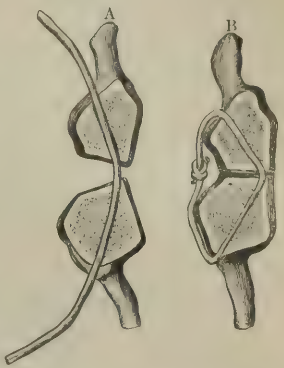


FIG. 95.—Wiring of the Patella (after Barker): A, fragments cut and cleaned and the wires passed; B, wires twisted and hammered down upon the bone.

Treves's Operation for Caries of the Lumbar and Last Dorsal Vertebræ.—In this operation the right loin is chosen for incision, as a rule. The instruments required are a scalpel, hæmostatic forceps, grooved director, an Allis dissector, sequestrum forceps, curette spoons, and a sand-bag.

Operation.—The patient lies upon his left side, with the knees drawn up and a sand-bag under him. The surgeon stands behind the patient (Barker). An incision is made at the outer border of the erector spinæ mass, reaching from the last rib to the iliac crest and going down at once to the lumbar fascia. The lumbar aponeurosis is opened, the erector spinæ is retracted inward, and the anterior portion of the erector spinæ sheath is incised. The quadratus lumborum muscle is next cut, and then the anterior leaflet of the lumbar aponeurosis is slit. Loose pieces of bone are removed with forceps, and cavities are thoroughly curetted. The wound is irrigated with corrosive sublimate and is dusted with iodoform; a large tube is inserted; the wound is packed with iodoform gauze, is partly closed by sutures of silkworm gut, and is dressed antiseptically.

Aspiration of Joints.—In certain cases of joint-effusion from inflammation, tubercular or otherwise, and sometimes in hemorrhage into a joint, it is desirable to remove the fluid by aspiration. The pneumatic aspirator is used (Fig. 96). The trocar and canula are thoroughly asepticized and the joint is prepared as for a set operation. The needle is entered at a surface free from vessels. The directions for using an aspirator are as follows: Insert the stopper firmly into a strong bottle (a clear glass one preferred), then attach the short elastic hose to the stop-cock B of the tube projecting from the stopper, and attach the other end of the same elastic hose to the exhausting or inward-flowing cham-

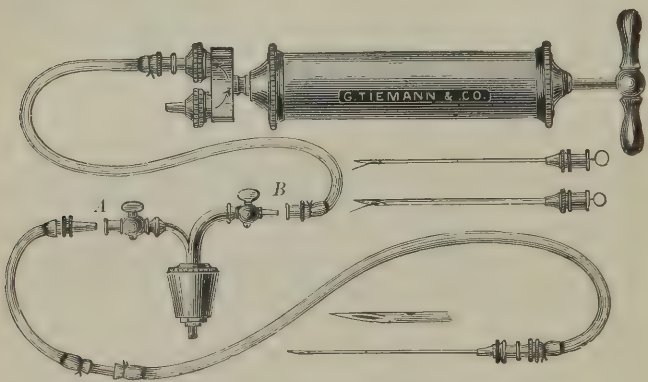


FIG. 96.—Aspirator and Injector.

ber of the pump. Next attach one end of the longer elastic hose to the stop-cock A projecting from the stopper, and the other end to the needle. Care should be taken that all the fittings or attachments are placed firmly into their respective places. Now close the stop-cock A and open stop-cock B, and by giving from thirty-five to fifty strokes of the pump a sufficient vacuum can be produced to fill with the fluid from the joint a bottle holding from a pint to a quart.

After having formed the vacuum, close the stop-cock B, and the instrument is ready for use. The trocar may be used to inject corrosive-sublimate solution, 1 : 1000 (Halstead), or carbolic-acid solution, 1 : 20. The joint is dressed antiseptically and is put at rest upon splints.

Excisions of Bones and Joints.—Excision or resection of a joint is the removal of the articular portions of the bones of the joint, and also the cartilage and synovial membrane. In the hip-joint and shoulder-joint the head of the long bone only may be removed, and not the articular surfaces of both bones. In excision enough bone is known to have been removed only when the remaining bone bleeds. Excision of a bone is the removal of an entire bone or of a portion of it. Excision is a conservative operation which often averts amputation.

Excision may be performed by the *open* method, in which the periosteum is not preserved, or it may be performed by the *subperiosteal* method, in which the periosteum is carefully separated by a rugine and the capsular ligament is preserved. *Arthrectomy*, or *erasion*, is the excision of the synovial membrane of a joint.

Excision may be employed for compound dislocation, and it is usually performed in compound dislocations of the elbow and the shoulder. Excisions for compound dislocations in other large joints are very dangerous; they should not be attempted in battle-field practice, and are to be avoided even in civil practice unless the patient is young and vigorous and every advantage can be given him during the operation and convalescence. Excision for deformity is rarely performed except upon the hip, the knee, and the shoulder, and these excisions must not be employed if the patient's condition leads one to fear the result of a protracted convalescence. Excision of the elbow, however, is usually a safe operation. In excising for deformity, always consider

the patient's trade and the demands of habitual position which it makes upon him.[1]

Excision is largely employed for joint disease, especially for tubercular joints. Bell states that attempts to preserve the limb without excision are more largely justifiable in the lower than in the upper limbs, because operation in the lower extremity is more dangerous than in the upper, and because a cure without operation in the lower limbs, if this cure can be brought about, gives as good a result as a cure by excision. In the upper extremities the danger from operation is less than is the danger from waiting. In a young subject an excision may remove the epiphysis, and thus lead to permanent shortening, which is productive of less inconvenience and deformity in the arm than in the leg. The great danger of excision operations is that the section may be made through cancellous bony tissue; hence suppuration, phlebitis, myelitis, septicæmia, or pyæmia may follow; further, in excision the cut is through diseased tissue, and a protracted convalescence is often inevitable. Amputation is effected through healthy tissue, and the convalescence is short. Excision, however, when successful, gives the patient a very useful limb.

Erasion, or Arthrectomy.—Erasion is the complete excision of diseased synovial membrane. This operation seeks to remove a depot of infection in an early stage of tubercular synovitis, and it possesses the conspicuous merit of not interfering with the epiphysis. Erasion is oftenest practised upon the knee-joint. The instruments required are a scalpel, hæmostatic forceps, dissecting forceps, toothed forceps, volsellum, scissors, bone-gouges, curettes, and an Esmarch apparatus.

Operation upon the Knee.—The patient lies upon his back; the limb is flexed with the sole of the foot planted upon the

[1] Joseph Bell, in his *Manual of Surgical Operations.*

table, and an Esmarch bandage is applied to a point well up on the thigh. The surgeon stands to the right of the patient. The incision starts in the mid-line of the thigh (on the side opposite to that occupied by the surgeon), about three inches above the patella; it is carried down across the ligament of the patella and up to a corresponding point on the opposite side of the thigh. This incision is made down to the bone; the flap is turned up and the joint exposed; the knee-joint is strongly flexed, and the synovial membrane and diseased ligaments are dissected away with scissors and forceps, great care being taken that the posterior ligaments (which, fortunately, are rarely implicated early in the case) are not divided and that the contents of the popliteal space remain intact. After removing the diseased ligaments and synovial membrane, examine the cartilage and remove any diseased portion, and then examine the bone and gouge away any tubercular foci. Ligate any exposed vessels, irrigate the wound and dust in iodoform, straighten the extremity, suture together the ends of the ligamentum patellæ, suture the skin after inserting a drainage-tube in each angle, dust iodoform over the wound, and dress antiseptically. Put the limb upon a posterior splint for a few days, then take out the drainage-tubes, re-dress antiseptically, and put up in a plaster-of-Paris dressing, cutting trap-doors upon each side and keeping the joint immobile for two or three weeks. This operation is only suited to early cases, in which it gives a good result, some capacity for motion being not unusually preserved.

Excision of the Shoulder-joint.—In the shoulder-joint *partial* excision is often performed, the head of the humerus being removed and the glenoid being undisturbed; but some patients require complete excision, the entire glenoid depression, as well as the head of the humerus, being removed by the surgeon. Excision of the shoulder-joint is made, if

possible, an intracapsular operation, the capsule being opened, but the capsular attachment to the anatomical neck not being interfered with. In bad cases, however, the capsular attachment must be destroyed. This operation is rare in civil, but is common in military practice; it is performed in gunshot wounds, in compound dislocations, in tubercular disease, and in tumors of the head and upper portion of the humerus. The instruments required are a scalpel, an Adams saw, an osteotome or chisel, a mallet, an Allis dissector, a periosteum-elevator, hæmostatic forceps, dissecting-forceps, toothed forceps, lion-jawed forceps, sequestrum forceps, metal retractors, curettes, and cutting bone-forceps.

Operation by Anterior Incision.—The patient lies supine; a pillow is placed beneath the shoulders, and a sand pillow is put beneath the shoulder to be operated upon. The arm is held to the side with the outer condyle forward and the bicipital groove inward (Barker's directions). The surgeon stands upon the affected side. An incision three or four inches in length is made from just external to the cora-

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FIG. 97.—1–10, AMPUTATIONS: 1, of lower third of forearm (Teale's); 2, at shoulder-joint by large postero-external flap (second method); 3, at shoulder-joint by triangular flap from deltoid (third method); 4, 5, through tarsus (Chopart's); 6, 7, at knee-joint; 8, by single flap (Carden's); 9, 10, of thigh (Teale's). A, excision of hip; B, of ankle-joint (Hancock's incision).

FIG. 98.—1–18, AMPUTATIONS: 1, amputation at wrist-joint (dorsal incision); 2, at wrist-joint (palmar incision); 3, at forearm (dorsal incision); 4, at forearm (palmar incision); 5, at elbow-joint (anterior flap); 6, at arm (Teale's); 7, at shoulder-joint (first method); 8, 9, of metatarsus (Hey's); 10, 11, at ankle (Syme's); 12, 13, of leg, posterior flap (Lee's); 14, at knee-joint (Carden's); 15, of thigh (B. Bell's); 16, of thigh (Spence's); 17, of thigh in middle third; 18, at hip-joint. A, excision of wrist (radial incision); B, of wrist (ulnar incision).

FIG. 99.—1–9, AMPUTATIONS: 1, of arm by double flaps; 2, at shoulder-joint; 3, at ankle-joint by internal flap (Mackenzie's); 4, 5, of leg just above the ankle-joint (Syme's); 6, 7, below the knee (modified circular); 8, through condyles of femur (Syme); 9, at lower third of thigh (Syme). A, excision of head of humerus; B, of knee-joint (semilunar incision).

FIG. 100.—1–8, AMPUTATIONS: 1, at elbow-joint (posterior flap); 2, at shoulder-joint, posterior incision (first method); 3, at ankle-joint (Mackenzie's); 4, through condyles of femur (Syme); 5, at lower third of thigh (Syme); 6, at knee (posterior incision); 7, of thigh (Spence's); 8, at hip-joint. A–G, EXCISIONS: A, excision of shoulder-joint (deltoid flap); B, of shoulder-joint (posterior incision); C, of elbow-joint (H-shaped incision); D, of elbow-joint (linear incision); E, of hip-joint (Gross's); F, of os calcis; G, of scapula.

FIG. 97.

FIG. 98.

FIG. 99.

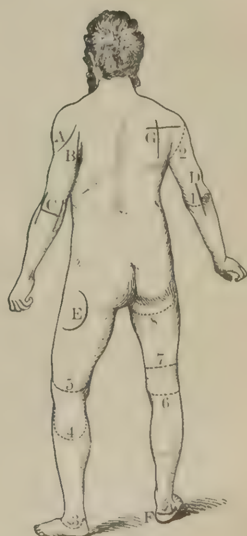


FIG. 100.

Amputations and Excisions (Joseph Bell ; see p. 484).

coid process, running straight down the humerus (Fig. 99, A). This incision divides the border of the deltoid muscle and brings into sight the long head of the biceps. The tendon of the biceps is retracted inward, unless it is diseased, in which case it is resected. The knife is carried up the groove and opens the capsule of the joint. The periosteum is lifted from the neck of the bone while an assistant rotates the elbow to make the muscles tense. In some places, if the periosteum tears, muscular insertions must be cut with a knife. The head of the bone is sawn off while the bone is in place, or the elbow is strongly pulled back, the head of the bone is forced out of the wound, and is then sawn off at the point required. In ordinary cases, remove only the articular head; in other cases make the section just above the surgical neck; in yet others remove a portion of the shaft. If the glenoid cavity is found diseased, any dead bone must be removed by the chisel and mallet or by the cutting-forceps. Scrape away all damaged tissue; ligate bleeding points; irrigate the wound with corrosive-sublimate solution; swab it out with a solution of chloride of zinc (gr. xx to ℥j); dust with iodoform; close the upper portion of the wound and insert a drainage-tube in the lower angle; dress the wound antiseptically; place a small pad in the axilla; apply the second roller of Desault; and put the patient in bed with a pillow under the affected shoulder. In seven days the hand-sling is substituted for the bandage, and with the elbow hanging free the patient is permitted to get up and is advised to move his arm frequently. Drainage is maintained until the wound is well healed from the bottom.

Excision by the deltoid flap is performed when the head of the bone is much enlarged (as by a tumor) or when the tissues are thick and indurated. The deltoid flap is in the shape of a V or is semilunar (Fig. 100, A). Raising this

flap exposes the head of the bone most satisfactorily. Bell states that when the glenoid cavity is chiefly involved the incision should be posterior (Fig. 100, A).

Excision of the Elbow-joint.—This operation is performed for wounds, faulty ankylosis, and chronic articular disease. Excision must be complete. Endeavor to make a subperiosteal resection; this maintains the shape of the articulation and gives the best chance for a movable joint. The instruments used are the same as those for the shoulder, plus a Butcher saw.

Operation.—The patient is "supine, but inclining to the sound side, the affected arm being held almost vertical, with the forearm flexed and nearly horizontal" (Barker). The incision is made on the posterior surface of the joint. A single posterior incision is usually employed (Fig. 100). An incision is made a little internal to the long axis of the olecranon, and reaching two inches above and two inches below the tip of the olecranon. This incision goes down to the bone, and throughout the entire operation the surgeon must guard and shield the ulnar nerve. The periosteum and soft parts are well separated; the olecranon is sawn off; forced flexion exposes the joint-cavity freely, and enables the surgeon to lift the periosteum and soft parts from the humerus; the humerus is sawed through at the beginning of its condyloid processes; the radius and ulna are cleared and are sawn at a level below that of the base of the coronoid process of the ulna. Cut and spoon away diseased tissues, the wound being irrigated, closed, drained, and dressed. In some cases an H-shaped incision is employed (Fig. 100, C), but the cicatrix of a transverse cut will limit flexion of the limb.

After excision of the elbow the patient is put to bed and the arm is laid upon a pillow, the elbow being placed midway between a right angle and complete extension, the fore-

arm being placed midway between pronation and supination. No splint is used, as a rule. The aim in treatment is to obtain a freely-movable joint. Passive motion is begun in one week,

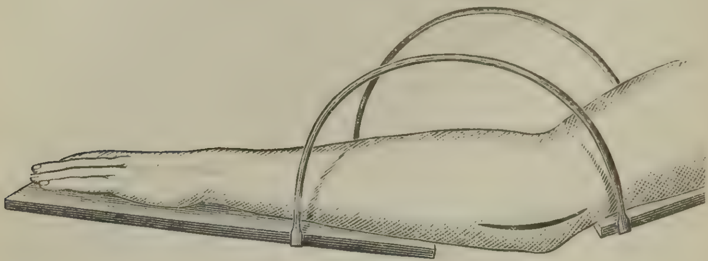


FIG. 101.—Esmarch's Splint for Excision of Elbow.

when the patient gets up. The hand is carried for a time in a sling. Esmarch used the splint shown in Figure 101.

Excision of the Wrist-joint.—Bell states that, whatever method of excision is chosen, three cardinal rules must be borne in mind: (1) Remove all the diseased bone, including the portions of the radius, ulna, carpus, and metacarpus which are covered with cartilage; (2) interfere with the tendons to the least possible degree; and (3) begin passive motion of the fingers very early. Many surgeons prefer the simple gouging away of diseased foci and the scraping of sinuses instead of a formal resection of the wrist, amputation being employed in severe cases or when scraping fails after several trials. Formal excision is not very often done, and the results cannot often be considered as very favorable.

Lister's Open Method of Excision.—The instruments required in this operation are the same as those used for any resection. Break up adhesions as completely as possible by forcible movements. Apply a tourniquet or an Esmarch apparatus. The patient lies upon his back, the arm and the forearm being brought, from stage to stage, into the most desirable positions. Begin an incision over the middle of the dorsum

of the radius, on a level with the styloid process; carry it downward in the direction of the inner edge of the articulation of the thumb with its metacarpal bone, and when the knife reaches the radial side of the second metacarpal bone, alter the direction of the incision and carry it downward in the long axis of the metacarpal bone to about its middle (Fig. 98, A). This is known as the *radial incision*, and the only tendon divided is that of the extensor carpi radialis brevior muscle. The tissues upon the radial aspect of the incision are dissected up, the tendon of the extensor carpi radialis longior muscle is divided at its point of insertion (Bell), and all the soft structures are retracted outward, exposing the trapezium, which is cut off from the rest of the carpus, but which is left in place, as its removal at this stage endangers the radial artery (Barker). By extending the hand the tendons are loosened and the carpus is cleared in the direction of the ulnar border of the hand.

Another incision is made, starting upon the inner surface of the wrist, two inches above the articular surface of the ulna, and midway between the ulna and the flexor carpi ulnaris tendon. This incision, which is known as the *ulnar incision*, is carried down until it is opposite the middle of the fifth metacarpal bone in the palm (Fig. 98, B). "The dorsal lip of this incision is raised" (Bell), and the extensor carpi ulnaris tendon is divided and dissected from its depression, but is not separated from the integument. The extensor tendons are lifted up; the ligaments upon the dorsum and sides of the wrist-joint are cut; the flexor tendons are lifted from the carpal bones; the pisiform bone is cut from the carpus, but is not yet removed; and the unciform process of the unciform bone is cut with forceps. The anterior radio-carpal ligament is divided, the carpo-metacarpal articulations are cut through, and the carpus is pulled out with bone-forceps. The ends of the radius and ulna are forced out of

the ulnar incision. All that portion of the ulna which is crusted with cartilage is to be removed, the saw-cut is to be oblique, and the base of the styloid process is to be left behind. A thin section is to be sawn from the radius, and the tendon-grooves are not to be impinged upon. The articular surface of the ulna is cut away with pliers (Bell). If foci of disease are discovered beyond these points, they are to be gouged out. The ends of the metacarpal bones are sawn off, and their articular facets are cut away by means of pliers. The trapezium is dissected out, the end of the first metacarpal bone is sawn off and its facet is cut away with pliers, and a portion of the pisiform bone is removed (the entire bone being removed if it be diseased). The wound is irrigated, vessels are tied, the radial incision is closed, the ulnar incision is partly closed, a drainage-tube is inserted by way of the ulnar incision, the wounds are dressed antiseptically, and the Esmarch apparatus is taken off. The forearm and hand are placed upon a splint which immobilizes the wrist and leaves the fingers semiflexed. The

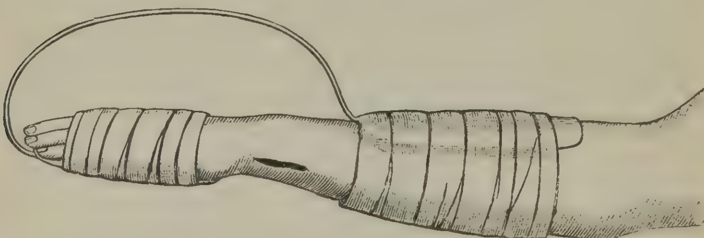


FIG. 102.—Esmarch's Interrupted Splint Applied.

splint is worn for many months, until the wrist-joint is immobile and solid. Esmarch uses the splint shown in Figure 102. Passive motion of the fingers is begun after thirty-six hours.

Excision of Metacarpal Bones and of Phalanges.—Excision of a metacarpal bone, except in cases of necro-

sis with the formation of large quantities of new bone, usually leaves a useless finger; hence amputation is preferred usually to excision. This rule does not apply to the metacarpal bone of the thumb, which is occasionally resected. The incision for this operation is made upon the dorsum, and is straight. Excision of the proximal phalanx of the thumb is sometimes performed. Excision for disease is rarely performed upon the finger-joints, amputation being preferred, though the operation is sometimes undertaken for compound dislocation. In the metacarpo-phalangeal joint of the thumb, excision, if it can be performed, is preferred to amputation. The incision for resection of this joint is placed upon the radial aspect.

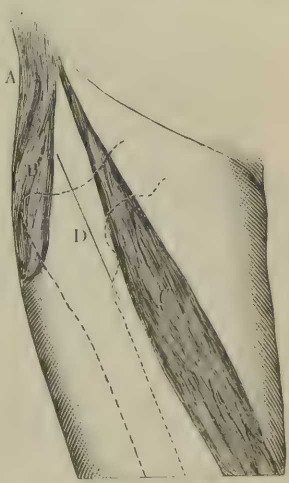


FIG. 103.—Excision of the Hip-joint: A, gluteus muscle; B, tensor vaginæ femoris muscle; C, sartorius muscle; D, anterior incision.

Excision of the Hip-joint.—Some surgeons advocate this operation; others, notably Marsh, are emphatically opposed to it. Excision should be performed in the early stage of tubercular disease *if less radical treatment has failed*, and in this stage the usual position of the limb is one of flexion, abduction, and eversion. In cases of long duration, especially where dislocation exists, excision is an easy and a comparatively safe operation; in recent cases it is difficult and carries with it decided dangers, but the peril of delay is greater than is the peril of an early resection. In cases of hip disease with involvement of the acetabulum the mortality is fifty per cent., whether operation is or is not attempted. Excision is performed especially for tubercular disease and

for gunshot injuries (Fig. 103). The instruments required are those used for other excisions.

Operation by Anterior Incision (Parker's Operation).—In this operation the patient is supine, with the thighs extended as thoroughly as circumstances permit. The surgeon stands to the right of the patient. An incision is begun half an inch below and half an inch external to the anterior superior iliac spine, and it is carried downward and a little inward for about three inches (Fig. 103, D). If dislocation exists, the incision must not be so long. This incision is carried at once deeply between the muscles, and the capsule of the joint is opened. The neck of the bone is divided from its upper surface downward with a saw or an osteotome, and without dislocating the bone through the wound by forcible extension and eversion. The head of the bone is removed. All tubercular foci are scraped away, and the gouge is used upon tubercular areas of the acetabulum. All sinuses are most thoroughly scraped. Bleeding is arrested, the wound is irrigated with corrosive-sublimate solution, mopped out with chloride-of-zinc solution, and dusted with iodoform. A drainage-tube is inserted at the lower angle of the incision, and the upper portion of the cut is closed. The wound is dressed antiseptically. Extension is made with the extension apparatus until healing has obtained a good headway, when a double Thomas splint is applied, so that the patient can be taken out daily in the air and sunlight. Seek to obtain a movable joint by passive motions. This joint will, however, rarely be very firm.

Operation by Lateral Incision.—In this operation a straight incision two inches long is made in the direction of the axis of the femur, and runs downward from the apex of the great trochanter. From the beginning of this incision a curved incision is carried toward the head of the bone, the convexity of the curve being backward (Fig. 97, A). Bell advises

the use of the saw after bringing the head of the bone into the wound by adduction and eversion of the thigh. Barker applies the saw with the bone *in situ*, and strongly opposes wrenching the bone out of the incision, because of the danger of peeling off the periosteum, which peeling, if it takes place, favors necrosis.

Incision of Gross.—In Gross's operation a semilunar flap is made with the convexity backward (Fig. 100, E).

Excision of the Knee-joint.—In this operation a complete excision should be performed, and the patella ought to be removed. This operation is performed in tubercular disease, in some compound fractures and compound dislocations, and in some cases of angular ankylosis, but it is not suitable for gunshot injuries, amputation being advisable (Ashurst). The instruments required are the same as those for the shoulder, plus Butcher's saw.

Operation by Anterior Semilunar Flap.—The patient lies upon his back, and the joint, if not ankylosed in extension, is semiflexed. The surgeon stands to the right side. An incision is made, at once opening the joint, starting from one condyle and reaching the other condyle by a downward curve which passes through the ligamentum patella midway between the tuberosity of the tibia and the inferior margin of the patella (Fig. 99, B). The flap is dissected up, the knee is thrown into forced flexion, the lateral ligaments and crucial ligaments are cut, and the end of the femur is well cleared. The blade of Butcher's saw is passed beneath the bone, which is sawn from below upward (Ashurst). The end of the tibia is cleared and a portion is sawn off. If, after sawing, diseased foci are discovered, another section can be sawn off or the foci can be gouged away. Prof. Ashurst, who is one of the highest of authorities, insists that in sawing through the femur the natural obliquity of the bone must be borne in mind and the section must be

made in "a line parallel to that of the free surface of the condyles." If the section is made transverse to the axis of the femur, "the limb, after adjustment, will be found to be markedly bowed outward." Ashurst says that the epiphyseal line is somewhat higher on the front than it is on the back of the femur, and in consequence the following rule is formulated for section of the condyles: The section of the condyles should be "in a plane which, as regards the axis of the femur, is oblique from behind forward, from below upward, and from within outward." Ashurst advocates section of the tibia "in a plane transverse to the long axis of the bone, with a slight antero-posterior obliquity, so as to correspond with that of the section of the condyles." Ashurst says also that the patella must be removed, whether it is diseased or not, and he quotes Pénière's observations to the effect that excision of the patella diminishes the risk of death one-third, and its retention doubles the chance of recovery without a future amputation.

After removing the patella the diseased synovial membrane is clipped away with scissors and all sinuses and diseased territories are well curetted. The posterior ligament of the joint is not removed unless it is diseased; its retention prevents displacement and guards the popliteal space. In children the fragments should be wired together; in adults this need not be done. After hæmostasis irrigate, dust with iodoform, insert a drainage-tube, suture, dress antiseptically, and adjust the limb upon Price's splint or Ashurst's bracketed wire splint. In some cases tenotomy is required to permit extension. If the bracketed splint is used, place it in a fracture-box. If the femur tends to project anteriorly, use an anterior splint. If there be a tendency to outward bowing, adopt Ashurst's expedient of carrying a strip of adhesive plaster around the outside of the limb and fastening it to the inner side of the splint. The splint is kept on until bony union is complete,

as in this operation a movable joint is never sought. Many surgeons use a plaster-of-Paris splint which is applied when healing is well advanced (Fig. 104).

FIG. 104.—Watson's Plaster-of-Paris Swing-splint.

Excision of the Ankle-joint.—This operation is performed chiefly in gunshot wounds, in compound dislocations, and in early cases of chronic joint disease. Complete resection is employed for chronic joint disease. Excision of the ankle is a rare operation. The instruments used are the same as those employed for any resection.

Operation (Hancock's Method).—In this operation the patient lies upon his back and the foot rests upon its inner side. The surgeon stands on the outer side of the damaged limb. Begin an incision just behind and two inches above the external malleolus, and carry it across the front of the joint to a corresponding point above and behind the internal malleolus (Fig. 97, B); this incision goes only through the skin, and the flap thus marked out is reflected. "Cut down upon the external malleolus, carrying the knife close to the edge of the bone both behind and below the process, dislodge the peronei tendons, and divide the external lateral ligaments" (Joseph Bell). Cut the fibula one inch above the malleolus by means of pliers; divide the tibio-fibular liga-

ment; turn the foot upon its outer side; dissect from their habitat back of the inner malleolus the tendons of the posterior tibial and the common flexor of the toes; carry the knife around the inner malleolus, close to the bony edge; separate the internal lateral ligament, and dislocate the lower end of the tibia through the wound by turning the sole of the foot downward; saw off the lower end of the tibia and the articular process of the astragalus, sawing away from the tendo Achillis, and remove the fragments with bone-forceps. Cut away diseased synovial membrane, and curette all sinuses and tubercular areas. Arrest bleeding, irrigate,

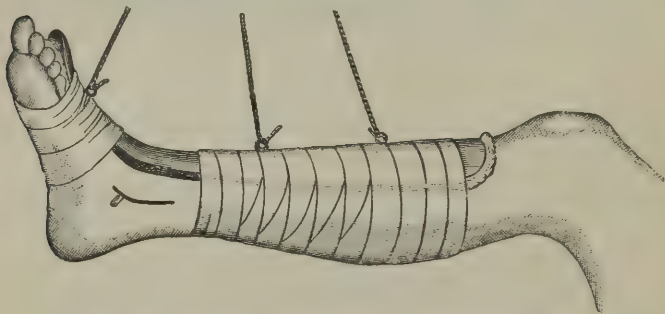


FIG. 105.—Volkmann's Dorsal Splint for Excision of the Ankle.

and drain. Sew up the wound, insert a tube at its outer angle, and pull it out at the inner angle. Apply antiseptic dressings, and put up the foot in fixed dressing or in splints at a right angle to the leg (Fig. 105). In Langenbeck's operation the excision is subperiosteal. If, in an excision of the ankle-joint, the astragalus is found extensively diseased, remove the entire bone.

Excision of the Os Calcis.—In caries limited to the os calcis most surgeons prefer to gouge away the dead bone, leaving the periosteum and, if possible, a shell of healthy bone, and draining thoroughly. Others advocate excision in some

cases. Extensive disease limited purely to the os calcis is rare, and most surgeons advise gouging for limited caries, and Syme's amputation in event of the disease extending beyond the periosteum or reaching adjacent bones.

Operation by Subperiosteal Method.—In this operation the position assumed by the patient is supine with the leg extended and the foot resting on its inner side. The incision, which cuts the tendo Achillis and reaches the bone at once, is begun at the upper border of the os calcis and the inner margin of the tendo Achillis, and is taken outward and horizontally forward to a point in front of the calcaneo-cuboid articulation. A vertical incision is begun near the forward termination of the initial incision, is carried across the outer edge and plantar surface of the foot, and terminates at the external margin of the inner surface of the os calcis. Some surgeons carry the vertical incision a little upward, toward the dorsum (Fig. 100, F). The periosteum is entirely stripped with an elevator, the os calcis is removed, the cavity is packed with iodoform gauze, the wound is stitched, a drain is inserted posteriorly, and the foot is dressed antiseptically and put up in plaster at a right angle to the leg, trap-doors being cut for drainage.

Excision of the astragalus is a rare operation.

Operation by the Subperiosteal Plan.—Barker advises an incision going at once to the bone, from the "tip of the external malleolus forward and a little inward, curving toward the dorsum of the foot." The foot is extended and turned inward, the periosteum is lifted, the bone is removed, and the wound is treated and the foot is dressed as is done in excision of the os calcis.

Excision of the Metatarso-phalangeal Articulation of the Big Toe.—In this operation, make a lateral incision and cut off or saw off the proximal end of the first phalanx and the distal third of the first metatarsal bone.

Excision of the Metatarsal Bone of the Big Toe (Butcher's Method).—In this operation a lateral straight incision is made, the periosteum is elevated, and the shaft is sawn from each extremity and removed.

Excision of the clavicle may be required in dislocation, in caries, in necrosis, for gunshot wounds, in tumor of this bone, as a preliminary to ligation of the artery and vein in certain cases of amputation at the shoulder-joint, or in cases of removal of the entire upper extremity. In excision of the clavicle the position of the patient is the same as that for ligation of the third part of the subclavian artery (p. 277). An incision is made down to the bone, from the sterno-clavicular joint to the acromio-clavicular articulation. If the case is suitable, the periosteum is stripped and the bone is sawn and removed; if not, the bone is sawn and each half is separately disarticulated. The wound is sutured and dressed, and the limb is put up in a Velpeau bandage.

Excision of the Scapula.—Complete excision of the scapula is most usually performed for tumors. Partial excision requires no detailed description, as it resembles the operation of sequestrotomy. In excision of the scapula the patient lies upon his sound side. Treves suggests the following incisions: One outside the vertebral border of the scapula, from its superior to its inferior angle; another from over the acromio-clavicular joint, along the acromion process and spine of the scapula to meet the first incision. Syme used an incision carried transversely inward from the acromion process to the vertebral border of the scapula, and another cut directly downward from the centre of the first incision (Fig. 100, G). In the method of Treves[1] the upper flap is reflected and the trapezius muscle is divided; the lower flap is reflected and

[1] Treves's *Manual of Operative Surgery*, one of the very best books now before the profession.

the deltoid muscle is divided. The patient's hand is placed on the sound shoulder; the muscles of the vertebral border are divided, the posterior scapular artery is tied, and while the vertebral border of the scapula is pulled toward the surgeon the serratus magnus muscle is cut, the upper border of the shoulder-blade is cleared, and the suprascapular artery is tied. The hand is now brought down to the side; the acromio-clavicular joint is disarticulated; the conoid and trapezoid ligaments are divided; the muscles of the coracoid process are cut; the capsule is incised, with the supraspinatus and infraspinatus, the subscapularis muscles, and the scapular origins of the biceps and triceps; and finally the teres major and minor muscles are divided, the subscapular artery is tied, and the bone is removed. The wound is stitched, a drain is introduced, and antiseptic dressings are applied. The patient lies upon his back until healing is well under way, when the arm is placed in a sling. The drainage-tube may be removed in twenty-four hours.

Excision of a Rib.—In caries the gouge and rongeur may remove the disease. In other cases excision is performed. In this operation the patient lies upon his sound side. The surgeon faces the patient. Make an incision down to the bone, in the long axis of the rib. The periosteum, if not diseased, is lifted from the bone, and the intercostal artery is thus saved from being cut. After sawing the bone beyond the limits of disease, remove it. During the sawing a metal retractor is held beneath the rib, between the rib and the periosteum. If the periosteum is diseased, remove it after tying the intercostal artery. Curette sinuses. Pack with iodoform gauze for some days. Sew up the wound except at one end. Dress antiseptically and apply a binder. If a rib is resected in order to drain the pleural cavity, remove it by the subperiosteal section, ligate the artery after one-half of the rib has been removed, cut away the periosteum to

prevent re-formation of bone, and open the pleura. (See *Operations upon the Chest* and *Estlander's Operation.*)

Complete Excision of One-half of the Upper Jaw.—The whole upper jaw has been removed, but in what follows only resection of one-half the jaw will be described. This operation is performed for malignant tumors of the superior maxillary bone or its antrum. Up to 1826, at which time Lizars of Edinburgh suggested the operation, tumors of the antrum were treated by scraping them away with a sharp spoon. Gensoul of Lyons in 1827 performed the first operation for resection of the upper jaw. This operation is not justifiable, except as a palliative measure, if the orbit is invaded, if the skin and subcutaneous tissues are infiltrated, or if the disease extends beyond the superior maxillary and palate bones. The instruments required are a mouth-gag; scalpels; strong scissors; dissecting, toothed, and hæmostatic forceps; bone-cutting forceps; lion-jawed and sequestrum forceps; tooth-extracting forceps; a volsella; a narrow-bladed saw; a chisel and mallet; a periosteum-elevator; a spatula or metal retractor; a Pacquelin cautery; sponges which are tied to sticks; needles, curved and straight; silk and catgut ligatures; silkworm-gut sutures; a Reverdin needle; and Horsley's antiseptic bone-wax.

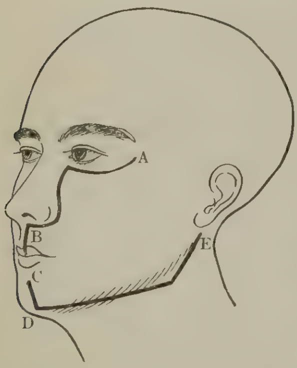


FIG. 106.—A B, Excision of the Upper Jaw; C D E, Excision of the Lower Jaw.

Operation by Median Incision.—The patient, whose face is shaved, is placed upon a Trendelenburg chair, and the head is lowered, thus avoiding the possible need of instant tracheotomy. The surgeon stands upon the right side of, and faces, the patient. The incisor tooth on

the diseased side is pulled out. The incision (Fig. 106, line A B) is begun half an inch below the inner canthus of the eye, and is carried along the side of the nose, around the ala of the nose, by the margin of the nostril, and through the middle of the lip. While the lip is being incised the assistant arrests hemorrhage by grasping the corners of the mouth, and after the lip is divided the coronary arteries are at once ligated. Some operators approach the mucous membrane cautiously and ligate the vessels before opening the cavity of the mouth. The upper portion of the wound having been compressed by another assistant during these manipulations, pressure is now removed and bleeding points are ligated. Another incision is now carried outward from the beginning of the first incision, along the orbital margin to well over the malar bone. The flap is lifted from the periosteum, and the bleeding from the infraorbital artery and the small vessels is restrained by pressure. The nasal cartilage is separated from the bone, and the nasal process of the superior maxillary is sawn (line A B, Fig. 107). The orbital periosteum is lifted up, and the orbital plate is cut with forceps from the saw-cut in the superior maxillary bone to the spheno-maxillary fissure (line B C, Fig. 107). The malar bone is sawn or is bitten through about its centre, the cut running into the spheno-maxillary fissure and taking a downward and outward direction (line C D, Fig. 107). The soft parts covering the hard palate are incised in the median line, a corresponding incision is made along the floor of the nose near the septum, and the

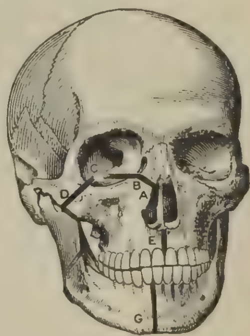


FIG. 107.—1. Excision of the Upper Jaw: A B, section of the nasal process; B C, section of the orbital plate; D, section of the malar bone and orbital plate; E, section of the alveolus and hard palate. 2. Excision of the Lower Jaw: G, section of the inferior maxillary; H, section of the ramus in partial resection.

soft palate is separated from the hard palate by a transverse cut. The saw is introduced through the nose, and the palate is sawn (line E, Fig. 107). The upper jaw-bone is grasped with Fergusson's lion-jaw forceps and removed, the removal being aided by the use of the scissors and bone-cutters; the latter are used to separate the upper jaw and the pterygoid process (Treves). Every vessel that can be seen is tied, and severe bleeding from bone is arrested by antiseptic wax. Oozing is controlled by hot water and pressure or by the Pacquelin cautery. Examine carefully to see if all the diseased area is removed; if it is not, use the gouge, scissors, chisel, and saw until healthy tissue is reached. The wound is packed with iodoform gauze, and the end of the strip is so placed as to be accessible through the mouth. The wound is sutured (the mucous membrane of the lip must be stitched, as well as the skin) and is dressed antiseptically (the eye being protected by aseptic gauze), and a crossed bandage of the angle of the jaw is applied.

Excision of One-half of the Lower Jaw.—In some rare instances the entire bone is removed. The lesions necessitating removal of the lower jaw are the same as in the case with the upper jaw. The instruments required are those used for excision of the upper jaw, plus a metacarpal saw (having a movable back) and a large curved needle.

In this operation the patient is placed in the same position as that for excision of the upper jaw, the chin being shaved. A vertical cut is made through the chin-tissue, starting below the margin of the lip and reaching to below the border of the jaw (C D, Fig. 106). From the point D an incision is carried outward below the border of the jaw and then back of the ramus, as shown in the line D E (Fig. 106). Treves's advice is to carry this incision down to the bone, except at the line of the facial artery, at which point it must only go through the skin. The facial artery is now to be sought

for, tied in two places, and divided. The periosteum is lifted from the external surface of the bone, from the symphysis outward. Hemorrhage is arrested. The buccal mucous membrane is cut from the alveolus. A lateral incisor tooth is pulled, and the bone is sawn in the line G (Fig. 107). The bone is grasped in a lion-jaw forceps and is drawn outward. The mylo-hyoid insertion is cut; the internal pterygoid muscle is cut or the periosteum at this spot is lifted; the inferior dental artery is cut and tied; the jaw is pulled down; the insertion of the temporal muscle upon the coronoid process is cut away; and the external pterygoid muscle is divided. The capsule of the joint is opened, and the bone is separated from the ligaments which still hold it in place. Bleeding is arrested, the wound is sutured, a tube is introduced in the posterior portion of the wound and retained for twenty-four hours, and antiseptic dressings and a Gibson or a Barton bandage are applied. Partial excisions of the alveolus may be performed through the mouth by means of chisels and rongeur forceps; but if any considerable part of the body of the jaw is to be removed, an incision should be made below the jaw.

XIX. DISEASES AND INJURIES OF MUSCLES, TENDONS, AND BURSÆ.

Myalgia, or **muscular rheumatism**, is a painful disorder of the voluntary muscles and of the fibrous and periosteal areas where they are attached. The term "muscular rheumatism" is not strictly correct. It is possible that in some cases the muscular structure is inflamed, but it is certain that in many cases the pain is distinctly neuralgic. Muscular rheumatism may be due to cold and wet, to over-exertion and strain, to acute infectious disorders, to syphilis, to chronic intoxications (lead, mercury, and alcohol), and to disturbances of the circulation. Gouty and rheumatic persons are

especially predisposed, men being more liable to the disease than women. The disease is usually acute, but it may be chronic.

Symptoms.—Muscular rheumatism is apt to come on suddenly. The pain, which may be very acute and lancinating or may be dull and aching, is in some cases constantly present; in other cases it is awakened only by muscular contraction. The pain is frequently relieved by pressure, though there is often some soreness. The disease usually lasts for a few days, but it tends to recur. There is little, if any, fever.

Lumbago is myalgia of the muscles of the loins. *Rheumatic torticollis* is myalgia of the muscles of the neck. Usually one side of the neck is attacked. The chin is turned from the affected side and the neck is stiff. *Pleurodynia* is myalgia of the intercostal muscles. The pain is very severe, is aggravated by deep respiration, by coughing, and by yawning, there may be tenderness, and the patient tries to limit chest-movement. In *intercostal neuralgia* the pain is limited, is not constant, but occurs in distinct paroxysms, and is linked with the tender spots of Valleix. Pleurodynia lacks the physical signs of pleurisy. Myalgia must not be confused with the pains of locomotor ataxia. *Cephalodynia* is myalgia of the muscles of the scalp. The muscles of the shoulder, upper dorsal region, abdomen, and extremities may also be attacked by myalgia.

Treatment.—Remove any obvious cause. Treat any existing diathesis, such as gout or rheumatism. Rest is of the first importance. For lumbago, put the person to bed. For pleurodynia, strap the side of the chest. A hypodermatic injection of morphia and atropia into the affected muscles at once allays the pain, and a deep injection of water is often curative. The introduction of four or five aseptic needles into the muscles, and their retention for a few minutes, often acts like magic. Ironing the muscles is a good domestic

remedy. Vigorous rubbing of the area with a piece of ice allays the pain. Hot poultices do good. If the pain is widely diffused, alters its seat, or is very obstinate, order hot baths or a Turkish bath and diuretics. In chronic cases employ blisters or counter-irritation by the cautery and give iodide of potash and nux vomica. The constant electric current finds advocates. In an ordinary severe case order a hot bath, put the patient to bed with a hot poultice over the part, and order 10 grains of Dover's powder; the next day give him four times daily a capsule containing 5 grains of salol and 3 grains of phenacetin.

Myositis may be a widespread inflammation of the voluntary muscles, due to an unknown infective cause. It is a disorder accompanied by pain and stiffness, by cutaneous œdema, and by various paræsthesiæ. Myositis resembles trichinosis, and is distinguished from it only by spearing out a bit of muscle and examining it microscopically. Occasionally diffuse suppuration occurs. Ordinary myositis arises from injuries, from syphilis, or from rheumatism, and it presents the usual inflammatory symptoms. Contraction and adhesion may follow.

Treatment.—Infective myositis is treated by anodynes, stimulants, nutritious food, hot applications, and rest. If pus forms, it should be evacuated. Rheumatic myositis calls for the salicylates, the alkalies, or salol. Syphilitic myositis is treated with mercury and iodide of potassium. The remedies employed for myalgia are used in traumatic myositis.

Hypertrophy of the muscles may arise from their increased use. In pseudo-hypertrophic paralysis the bulk of the muscle is greatly augmented, but it contains less muscle-structure and more fat or connective tissue. Hypertrophy of the tongue, which is due to lymphangioma, is called "macroglossia" (see p. 209).

Atrophy of the muscles arises from want of use, from

injury, from continuous pressure, from interference with the blood-supply, from disease of the nerves or their centres, or from lead-poisoning.

Degeneration of Muscles.—The muscles may undergo granular degeneration, waxy degeneration, fatty degeneration, and calcareous degeneration, and may become pigmented.

Local Ossification and Myositis Ossificans.—It is not unusual for a small portion of bone to form in the bony insertion of a muscle which is subjected to frequent strain. In persons who ride many hours a day there not unusually develops the "rider's bone," which is an area of ossification in the adductor muscles of the thigh. *Myositis ossificans*, a widespread ossification of the muscles, is a rare disorder the cause of which is unknown, and which, if not congenital, begins at least in early life.

Tumors of the Muscles.—Primary tumors of the muscles are rare. Among those which may occur are sarcoma, fibroma, lipoma, osteoma, angeioma, myxoma, and enchondroma.

Syphilis may cause inflammation. Gummata may form, or gummatous infiltration may take place.

Trichinosis or **trichiniasis** is a disease due to the embryos of the trichinæ spiralis. The disease originates from eating insufficiently cooked meat which contains the trichinæ. These nematodes are thus carried into the intestine, there to develop and to multiply. In from seven to nine days a horde of embryos have developed in the intestines, and they leave the intestine by passing through the peritoneum or by means of the blood, and finally reach the connective tissue of the muscles. From the connective tissue the embryos migrate into the primitive muscle-fibres, where they dwell and enlarge. Myositis develops, and in the course of five or six weeks the parasites become encapsuled and develop

no further. The cyst-wall may calcify, and the worm may become calcified or it may live for years. Because infected meat is eaten the disease does not inevitably develop, and a few embryos lodged in muscle may cause no symptoms.

Symptoms.—The symptoms of trichinosis often appear in a day or two after eating infected meat. The symptoms of acute gastro-intestinal catarrh or of cholera morbus are common, but in some cases no gastro-intestinal manifestations usher in the disease. In from seven to fourteen days after the infected meat is eaten the migration of the parasites develops obvious symptoms. A chill may be noted; there is usually fever; muscular pain, tenderness, swelling, and stiffness are complained of. This condition may be widespread. Involvement of the muscles of mastication interferes with chewing; of the larynx, with audition and respiration; of the intercostals and diaphragm, with respiration. Skin-œdema and itching are marked. In some cases delirium exists. The writer saw in the Philadelphia Hospital one fatal case which was mistaken for erysipelas because of the high fever, the delirium, and the œdematous redness of the face and neck. Dyspnœa is frequent. Mild cases get well in a week or two; severe cases may last many weeks. The mortality varies in different epidemics from 1 to 30 per cent. (Osler). The diagnosis is made by spearing out a piece of muscle which is then examined for trichinæ under a microscope; or the worm may be detected in the feces by means of a pocket-lens.

Treatment.—To treat trichinosis, employ purgatives (senna and calomel) early in the case, and give glycerin, and also santonin or filix mas. When muscular invasion has taken place, sedatives, hypnotics, nourishing diet, and stimulants are indicated.

Wounds and Contusions of the Muscles.—*Wounds* of muscles may be either *open* or *subcutaneous.* In a longitudinal

wound the edges lie close together, and hence drainage must be thorough. In a transverse wound the edges separate widely, and catgut stitches must be inserted. *Contusions* of muscles, like contusions of other tissues, vary in extent and in severity. There are pain (which is increased by attempts to use the muscle), loss of function, swelling beneath the deep fascia, and discoloration, which may appear at once because of superficial damage from the initial injury, or which may appear in dependent parts after many days by gravitation of the blood and the blood-stained serum. As a result of contusion, suppuration, inflammation, or atrophy may arise.

Treatment.—The indications in wounds and contusions of muscles are to obtain rest by means of splints and to secure relaxation. Limitation of swelling is secured by bandaging. Inflammation is combated first by cold and lead-water and laudanum, later by iodine, blue ointment, ichthyol, and intermittent heat. To prevent loss of function, employ, as soon as the acute symptoms subside, massage, passive motion, and stimulating liniments, and, later in the case, electricity (galvanism if the reactions of degeneration exist, faradism if they are absent).

Strains and Ruptures.—A strain is a stretching of a muscle with a small amount of rupture. The muscle is swollen, tender, stiff, weak, and sore, and attempts at motion produce sharp pain. Strains are common in the deltoid, the hamstring muscles, the back, the calf, the biceps, and the great pectoral. "Lawn-tennis arm" is a strain of the pronator radii teres muscle. "Rider's leg" is a strain of the adductor muscles of the thigh.

Treatment.—A strain is treated in the same way as is a contusion.

Rupture of a muscle is announced by a sudden and violent pain and by loss of function during powerful muscular

contraction or strong traction on a muscle. The rupture may be announced by a distinctly audible snap (A. Pearce Gould). A distinct gap is felt between the ends; great pain develops on movement; there are tenderness and swelling. Strains and ruptures may be followed by atrophy, as are contusions.

Treatment.—In treating rupture of an important muscle, when the ends are widely separated, incise with every aseptic care, unite the divided ends by catgut sutures, and sew up the skin with silkworm gut. Treat the part in any case by rest and relaxation, and combat inflammation by appropriate means. Passive motion and massage are employed as soon as union is firm.

Hernia of Muscles.—When a breach exists in a muscular sheath, a portion of the muscle protrudes. The *treatment* is incision and the stitching of the fascia.

Contractions of muscles may result from injury, from joint-disease, from malposition of parts (as in old dislocation or torticollis), or from diseases of the nervous system. The *treatment* in some cases is sudden extension, in other cases gradual extension, tenotomy, or myotomy. Macewen recommends the making of a number of V-shaped incisions in the muscle. In some cases of spasmodic contraction nerve-stretching is of value.

Dislocation of Tendons.—The long head of the biceps is oftenest displaced. The flexor carpi ulnaris and the peroneus brevis may be dislocated. Most of these accidents are associated with chronic joint disease or with fracture, but displacement may exist as a solitary injury.

Symptoms.—In dislocations of the tendons the muscle will contract, but it acts at a disadvantage; thus the corresponding joint exhibits partial loss of function. The displaced tendon can be felt, and a hollow exists where it used to reside.

Treatment.—In tendon-dislocation reduction is easy, but the displacement is apt to recur because of laceration of the sheath. The treatment is by splints and by lead-water and laudanum. Passive movements are begun at the end of the first week. Even if the tendon will not stay reduced, a useful joint will be obtained. Wood of New York advised in obstinate cases tenotomy and immobilization. Open incision may be necessary.

Wounds of Tendons.—Subcutaneous wounds of tendons are usually inflicted by the surgeon, and they heal well. Open wounds require rigid antisepsis and the suturing of the tendon. In wounds of the wrist especially always suture the tendons (Figs. 109 to 112), and be sure to bring the proper ends into apposition.

Rupture of Tendons.—A violent muscular effort may rupture a tendon, and a snap can often be heard. The *symptoms* are sudden pain and loss of power, fulness of the associated muscle from retraction, and absolute inability to bring the tendon into action. A gap can often be felt in the tendon.

Treatment.—The best procedure in treating rupture of a tendon is incision and tendon-suture. Some surgeons relax the parts and apply splints.

Thecitis or **teno-synovitis** is inflammation of the sheath of a tendon.

Acute thecitis may arise from a contusion, from a wound, from repeated over-action in working, from rheumatism, from gonorrhœa, or from syphilis.

Symptoms.—In *non-suppurative* cases of thecitis the symptoms are pain, swelling, tenderness, and moist crepitus along the tendon-sheath, due to inflammatory roughening. The crepitus disappears as the swelling increases, but it reappears as the swelling diminishes. In *suppurative* cases the symptoms are great swelling, pulsatile pain, dusky discoloration,

inflammation spreading up the tendon-sheaths, and the constitutional symptoms of sepsis.

Treatment.—In treating non-suppurative thecitis, employ splints and apply locally iodine, blue ointment, or ichthyol. Treat any causative constitutional state. In the suppurative form make free incisions, irrigate, and drain.

Palmar Abscess.—A suppurative thecitis of the flexor tendons of the fingers travels rapidly upward and is apt to produce a palmar abscess. Thecitis of one of the three middle fingers is usually arrested at the lower end of the palm, but suppurative thecitis of the thumb or the little finger diffuses pus over a large surface of the palm and also up the arm. Palmar abscess is a most serious affection. The pus may dissect up all the structures of the palm, may reach the dorsum, or may pass beneath the anterior annular ligament into the connective-tissue planes of the forearm.

Treatment.—A palmar abscess demands free incision and drainage at the earliest possible moment. The incision is made in the line of the metacarpal bone. A line transverse with the web of the thumb is below the palmar arches. In an incision above this line, try not to cut the arch, but if it be cut, ligate at once.

Chronic thecitis is usually a tubercular inflammation of a tendon-sheath. The swelling is firm or doughy when due to granulation tissue, but is fluctuating when due to fluid. Grating is marked. The tendon-sheath may contain numerous small bodies which are either free or are attached (rice, riziform, or melon-seed bodies). Tubercle bacilli are present in the fluid or in the granulation tissue. Chronic thecitis is commonest in the tendons of the fingers, the ankle, and the knee; it may spread to a joint or it may arise from a tubercular joint. This condition causes very little pain.

Treatment.—In cases of fluid effusion, make a small in-

cision, wash out with iodoform emulsion, and close the wound. In cases of rice bodies, open the sheath, evacuate the contents, scrape the walls thoroughly, inject with iodoform emulsion, and close the wound. (If the annular ligament is divided, stitch it together; Fig. 112.) In cases with extensive formation of embryonic tissue, apply an Esmarch bandage, make a large incision, and remove all infected tissue from the sheath, around the sheath, and from the tendon.

Ganglia.—In connection with tendon-sheaths simple ganglia may develop. They are small, tense, round swellings, which are firm, grow progressively though slowly, are painless when uninflamed, and contain a fluid of the appearance and consistence of glycerin jelly (Bowlby). These ganglia are commonest upon the dorsum of the wrist, and they occur especially in those who constantly use the wrist-muscles. Paget states that a *simple* ganglion is due to cystic degeneration of a synovial fringe inside a tendon-sheath, and that the fluid of the ganglion does not communicate with the fluid of the tendon-sheath. Other pathologists believe a simple ganglion to be a hernia of synovial membrane through a rent in a tendon-sheath, all way of communication being soon obliterated. *Compound* ganglion is an old name for tubercular thecitis.

Treatment.—Ganglia are treated by aseptic puncture with a tenotome, evacuation, scarification of the walls, antiseptic dressing, and pressure. An old-time method of treatment was subcutaneous rupture brought about by striking with a heavy book. Recurrent ganglia, very large ganglia, and ganglia with very thick contents should be dissected out.

Felon, whitlow, or **paronychia** is a suppuration of a finger or a toe due to abrasion which may be very slight, pus organisms being carried inward. The commonest seat of a felon is the last digit of a finger, because the superficial

lymphatics run directly inward. *Superficial* felon usually occurs in children and in persons broken down in health. More than one finger is apt to be attacked, and the felon usually appears as a suppuration around the nail (a ring-around). The *symptoms* are pain, suppuration, and, in bad cases, loss of the nail. In *deep* felon (bone-felon) the finger is very hot, tense, and painful, the pain being pulsatile and much increased by motion, by pressure, or by a dependent position. Pus soon forms. An abscess may form in the superficial tissues as well as in the depths.

Treatment.—A superficial felon demands instant incision in all cases, and the patient should subsequently be ordered tonics and a change of air. A bone-felon should be incised at once to the bone alongside the tendon. Do not wait for pus to form, but allay tension and prevent pus-formation by early incision. Do not waste time with poultices: to wait means agonizing pain, sleepless nights, constitutional involvement, and perhaps sloughing of tendons or death of the bone. Incision and drainage constitute *the* treatment, followed by irrigation, antiseptic dressing, and splinting of the extremity. If the patient cannot sleep, give morphia. See that the bowels are moved once a day. Give quinine, iron, and milk punch. Opening a felon is exquisitely painful; hence ether should be given to the first stage, nitrous oxide should be administered, or the superficial parts should be frozen by a spray of chloride of ethyl.

Bursitis is the inflammation of a bursa. Acute bursitis arises from strain or from traumatism. The *symptoms* of acute bursitis are pain, limited swelling, moist crepitus, fluctuation, and discoloration in the anatomical position of a bursa. Bursitis of a deep bursa is hard to separate from synovitis; indeed, the joint is apt to become secondarily affected. Suppuration may take place. *Chronic* bursitis may follow acute bursitis, or the disease may be chronic from

the start. Its *symptom* is swelling with little or no pain unless acute inflammation arises.

Treatment.—Acute bursitis is treated at first by rest and pressure and with lead-water and laudanum; later with iodine, blue ointment, or ichthyol. If the swelling persists, aspirate. If pus forms, incise, swab out the sac with pure carbolic acid, and pack it with iodoform gauze. If some causative diathesis exists, it should be treated.

Housemaid's knee is thickening and enlargement of the prepatellar bursa due to intermittent pressure. In effusion into the knee-joint the fluid is behind the patella and the bone floats up; in housemaid's knee the fluid is above the bone and the osseous surface can be felt beneath it. "Miner's elbow," which is a condition similar to housemaid's knee, affects the olecranon bursa.

Treatment.—Housemaid's knee is treated by incision and packing with iodoform gauze. In bursitis of the bursa beneath the ligamentum patellæ, if rest and blistering fail to cure, aspirate or incise. In bursitis below the tendon of the semimembranosus, incise or aspirate.

Bunion.—A bunion is a bursa due to pressure, and it is most commonly found above the metatarso-phalangeal articulation of the great toe, but occasionally over the joint of another toe. When the big toe is pushed inward by ill-fitting boots a bunion forms. When a bunion is not inflamed it may cause but little trouble, but when it is inflamed the bursa enlarges and the parts become hot, tender, and excessively painful. Suppuration may occur and pus may invade the joint, and the bone not unusually becomes diseased.

Treatment.—In treating a bunion the patient must wear shoes that are not pointed, that have the inner borders straight, and that have rounded toes (Jacobson). For a mild case a bunion-plaster gives comfort. Dr. Sayre advises

the use of a linen glove over the phalanges, which are to be drawn inward by a piece of elastic webbing one end of which is fastened to the glove and the other end to a piece of strapping from the heel. A special apparatus may be worn (Fig. 108). In many cases osteotomy of the first phalanx or of the first metatarsal bone is required; in some cases excision of the joint is necessary; in others amputation must be performed. When the bursa is not inflamed, but only thickened, blisters should be employed over it, or there should be applied tincture of iodine, ichthyol, or mercurial ointment. When the bursa inflames, lead-water and laudanum is applied, and intermittent heat by foot-baths gives relief. Suppuration demands immediate incision and antiseptic dressing. If an ulcerated bunion does not heal by antiseptic dressing, stimulate it with silver and dress it with unguent. hydrarg. nitrat. (1 part to 7 of cosmoline). Jacobson recommends skin-grafting for some cases.

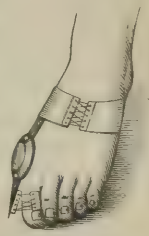


FIG. 108.—Bigg's Apparatus for Bunions.

Operations upon Tendons.—**Tenotomy** is the cutting of a tendon. It may be *open* or *subcutaneous*, the open operation being preferred in dangerous regions, and the method of its performance being obvious. The subcutaneous method will here be described.

Tenotomy of the Tendo Achillis.—In this operation the tendon is cut about one inch above its point of insertion. The instrument used is a sharp tenotome. The patient lies upon his back "with his body rolled a little toward the affected side" (Treves), the foot being placed upon its outer side on a sand pillow. The surgeon stands to the outside. The tendon is rendered moderately rigid, and the sharp tenotome, with its blade upward, is carried inward along the anterior border of the tendon until the surgeon's finger feels the knife on the outer side. The tendon is now drawn

into rigidity, and the surgeon turns the blade of his knife toward the tendon, places his finger over the skin, and saws toward his finger. The tendon gives way with a snap. Treves states that a beginner is apt not to push his knife far enough toward the outside or he may push his knife through the tendon; in either case the tendon is not completely cut. The little wound, which is covered with a bit of gauze, will be entirely closed in forty-eight hours. In club-foot cases after tenotomy some surgeons at once correct the deformity and immobilize the limb in plaster; some partially correct the deformity and apply plaster for one week, at which time they remove the plaster, partly correct the deformity, reapply the plaster, and so on; other surgeons do not attempt correction of the deformity until the cut tendon has begun to unite, when they gradually stretch the new material.

Tendon-suture and Tendon-lengthening.—The instruments required in these operations are an Esmarch apparatus;

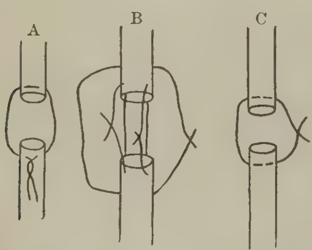


FIG. 109.—Tendon-sutures: A, of Le Fort; B, of Le Dentu; C, of Lejars.

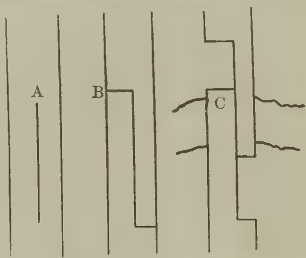


FIG. 110.—Anderson's Method of Tendon-lengthening.

curved needles and needle-holder; chromicized gut, kangaroo tendon, or silk for an ordinary case, silver wire for a suppurating wound. In performing tendon-suture, make the part aseptic and bloodless; find the ends of the tendon, and be sure the proper ends are brought into contact; stitch them together with a continuous suture or with one of the sutures shown in Figure 109, A, B, and C. In a suppurating wound

suture by silver wire should be tried, though it usually fails. After suturing, remove the Esmarch apparatus, arrest bleeding, suture the wound and dress it antiseptically, relax the parts, and place the limb on a splint. If a flexor tendon of the wrist is cut, approximate the ends by flexing the finger of the cut tendon and extending the other fingers. If, after suturing, there is much tension, stitch the cut tendon above the sutures to an adjacent tendon. Dress with plaster, the finger of the cut tendon being flexed, the others being extended. Begin passive motion after one week. If only one end of the tendon can be found, graft it upon the nearest tendon with a like anatomical course and function. In old injuries, when the ends cannot be brought into apposition, lengthen one end or both ends either by the method of Czerny (Fig. 111) or by the method of Anderson (Fig. 110).

FIG. 111.—Czerny's Method of Tendon-lengthening.

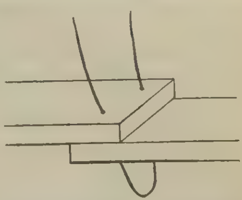


FIG. 112.—Method of Suturing the Annular Ligament of the Wrist.

These methods of lengthening may be used in cases of deformity from a contracted tendon. If the tendon cannot be lengthened sufficiently, make a bridge of catgut from one end of it to the other, or graft in another tendon from the same person or from one of the lower animals.

The annular ligament is sutured as shown in Figure 112.

XX. ORTHOPEDIC SURGERY.

This branch of surgery formerly dealt only with the treatment of deformities by means of mechanical appliances, but of recent years its domain has been enlarged to include the treatment, surgical and mechanical, of deformities, contractures, and many joint diseases.

Torticollis (wry-neck) is a condition in which contraction of certain of the neck-muscles causes an alteration in the position of the head. The disease is one-sided; the sterno-cleido-mastoid is the muscle chiefly involved, though the trapezius, splenius, and other muscles sometimes suffer. Acute torticollis, which is rare, results from cold or from injury (see *Myalgia*). Chronic torticollis may be congenital, it may be due to nerve-irritation, or it may be due to an assumed attitude because of eye-defect. Chronic torticollis may be intermittent, but is usually spastic. The muscle stands out in bold outline, the head is turned to the opposite side, the ear of the disordered side is turned toward the shoulder, and the chin is thrown forward. There is no pain. Spinal curvature may arise. The head can often be restored to its normal position by passive movement or by voluntary effort, but it at once returns to its habitual position. The corresponding side of the face atrophies.

Symptoms.—Congenital wry-neck is due to central nervous disease, to spinal deformity, or to injury during delivery, and in this form the sterno-mastoid is shortened, hardened, and atrophied. It may not be noticed for some years because of the short neck of infancy, and it is associated with asymmetrical development of the face. It is almost invariably upon the right side. *Spasmodic* wry-neck may present tonic spasm only, intermittent spasm alone, or both may appear alternately. It is a disease especially of adults; in women it is often linked with hysteria. The exciting cause may be a cold, a blow, or a mental storm; the predisposing cause is the neurotic temperament. In some rare cases bilateral spasm occurs, the head being pulled backward and the face being turned upward. Clonic spasms may come on unannounced, or they may be preceded by pain and stiffness; the head can be held still for a moment only; there is sometimes pain, always fatigue, but during sleep the contrac-

tions cease. The attack will probably pass away, but will almost certainly recur.

Treatment.—Congenital wry-neck is treated by tenotomy (through an open wound) and the use of proper braces and supports. The old subcutaneous tenotomy should be abandoned, as aseptic incision enables the surgeon to see and to feel all the contracted bands of fascia, muscle, and tendon, and to avoid dangerous structures. In spasmodic wry-neck treat the neurotic temperament; in persistent cases stretch, or divide and exsect a part of the spinal accessory nerve. To reach this nerve, make an incision along the posterior edge of the sterno-cleido-mastoid, find the nerve as it emerges from under the middle of the muscle, and retract the muscle at this point. For the treatment of rheumatic wry-neck see *Myalgia* (p. 504).

Dupuytren's contraction is a contraction of the palmar fascia, of its digital prolongations, and of the fibres joining the fascia and skin. Fixed contraction of one or of more fingers occurs. The ring-finger and the little finger most often suffer. The disease arises oftenest in men beyond middle age. The *cause* of this disease is unknown: some think it is gout or rheumatism, others that it is traumatism, reflex irritation, or neuritis.

Symptoms.—Dupuytren's contraction is indicated by a small hard lump or crease which appears over the palmar surface of the metacarpo-phalangeal joint. This nodule grows and the corresponding finger is pulled down. In some cases the tip of the finger is forced against the palm. The skin becomes dimpled or puckered.

Treatment.—In treating Dupuytren's contraction subcutaneous multiple incisions may be made, the tense fascia and the fascio-cutaneous fibres being cut. The finger is straightened and is placed upon a straight splint, which is worn continuously for a week or ten days and is worn at night

for at least a month. Dr. Keen divides the skin by a V-shaped cut, the base of the V being down, and dissects out the contracted tissue.

Syndactylism (webbed fingers) is always congenital, and may persist through several generations. Simple incision of the web is useless; the operation to be performed is that of Agnew or of Diday (Figs. 113, 114).

FIG. 113.—Agnew's Operation for Webbed Fingers (Pye).

FIG. 114.—Diday's Operation for Webbed Fingers (Pye).

Polydactylism (supernumerary digits) is always congenital, is often hereditary, and is usually symmetrical. There may be an incomplete digit, or there may be an entire and well-developed finger or toe with a metacarpal or metatarsal bone. The connection to the metatarsus or metacarpus may be by a fibrous pedicle only. If the digit is complete, with a metacarpal bone, no operation is required; if it is incomplete or is ill-developed, it should be removed.

Genu valgum (knock-knee) results from an unnatural growth of the internal condyle, causing the shaft of the femur to curve inward and the internal lateral ligament of the knee-joint to stretch, the knees coming close together and the feet being widely separated. This deformity is usually noted when the child begins to walk, but it may not appear until puberty or even long after. Knock-knee may arise from rickets, from an occupation demanding prolonged standing, or from flat-foot. It may be noted in one knee or in both knees.

Treatment.—Mild rhachitic cases of knock-knee may remain in slight deformity or may get well from improvement of the general health. In ordinary cases, simply treat the rickety condition. The patient is forbidden to stand or to walk, and the limb, after being put as straight as it can be, is fixed on an external splint and a pad is put over the inner condyle. Later in the case plaster-of-Paris is used. Some surgeons prefer to immobilize, in which case the leg is flexed to a right angle with the thigh. In a severe case the surgeon can immobilize after forcibly straightening (causing an epiphyseal separation) or after the performance of osteotomy (Fig. 90). Osteotomy is preferable to fracture by a mechanical appliance (osteoclasis).

Genu varum (bow-legs) is the opposite of knock-knee. Usually both legs are bowed *out*, the knees being widely separated, the tibiæ and femurs, as a rule, being curved, and the feet being turned in. This disease is due to rickets, the weight of the body producing the deformity in early life. In older people incurable bow-legs may arise from arthritis deformans.

Fig. 115.—Talipes Equinus (Albert).

Fig. 116.—Talipes Calcaneus (Albert).

Treatment.—Some mild cases of genu varum recover from improvement of the health. Ordinary cases are treated by braces, by plaster-of-Paris bandages, and by attention to the general health. When the bones have hardened, osteotomy or osteoclasis is indicated.

Talipes (club-foot) is a deviation of the foot not due to traumatism. *Talipes equinus* (Fig. 115) is a confirmed extension; *talipes calcaneus* (Fig. 116) is a confirmed flexion; *talipes varus* is a confirmed adduction; and *talipes valgus* is

a confirmed abduction. Two of these forms may be combined, as in equino-varus (Fig. 117). The *causes* of talipes are under-action of some muscles, over-action of other muscles, or abnormality of bony form or position; it may be congenital or it may be acquired. The acquired form arises from infantile paralysis; the congenital form is due to persistence of the fœtal form of the foot.

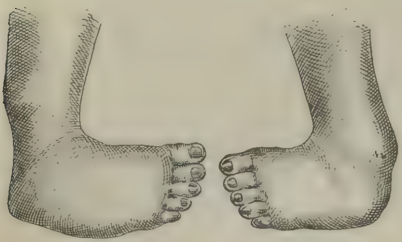


FIG. 117.—Double Equino-varus (*Am. Text-book of Surgery*).

Symptoms and Treatment.—In club-foot the position is obvious. In congenital cases the condition is usually manifest on both sides, and is nearly always talipes equino-varus. Congenital club-foot, where a restoration to position can take place, is treated by plaster-of-Paris bandages. If a child has begun to walk, it may still be possible to correct the deformity eventually by manipulations, by plaster-of-Paris bandages, or by club-foot shoes, but most cases require tenotomy of the tendo Achillis before the application of the shoe or the plaster. The club-foot shoe may do good service, but in many instances it is painful and is not so efficient as plaster. In severe cases, before applying the plaster, the patient is given ether; the surgeon cuts the tendo Achillis, the tendons of the anterior and posterior tibial muscles, and the plantar fascia, and forcibly corrects the deformity. In old cases with alteration in the shape of the bones, cuneiform osteotomy (p. 474), or the removal of the cuboid or other tarsal bones, is indicated. In these cases Phelps advises a transverse incision through all the plantar soft parts. In talipes due to infantile paralysis the operative treatment is the same. Do not immobilize in plaster, but rather in some

apparatus which can easily be removed to permit the use of massage and electricity. In some cases of talipes calcaneus the surgeon may be forced to shorten the tendo Achillis.

Pes planus (flat-foot) is the loss of the arch of the foot, due to ligamentous weakness and to prolonged standing. This condition is productive of much pain on standing. Flat-foot can at once be recognized by wetting the sole of the patient's foot with a colored fluid and causing him to step firmly upon a piece of paper (Fig. 118, A, B).

FIG. 118.—Print of a Normal Foot-sole (A) and of a Flat Foot-sole (B) (Albert).

Treatment.—To treat flat-foot deformity a shoe should be made containing a piece of steel so arranged as to raise the arch of the foot. The patient's general health must also be looked to.

Pes cavus (hollow-foot) is an increase in the arch of the foot, due to contraction of the peroneus longus muscle or to paralysis of the muscles of the calf. It is the opposite of flat-foot.

Treatment.—A shoe is worn containing a plate of steel in the sole, and pressure is applied over the instep. Tenotomy, cutting of the plantar fascia, or excision of bone may be required.

Hallux valgus or **varus,** a displacement of the great toe outward or inward, may occur in the young, but it is most frequent in old men; it may be due to rheumatic gout. In hallux valgus a bunion is apt to form.

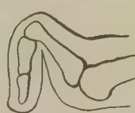


FIG. 119.—Hammer-toe.

Treatment.—An arrangement may be worn to straighten the toe and to protect the bunion, osteotomy may be performed upon the metatarsal bone, the joint may be excised, or amputation may be required.

Hammer-toe (Fig. 119) is the flexion of one or more toes at the first interphalangeal joint. Shattuck shows that this

condition is due to contraction of "the plantar fibres of the lateral ligaments of the joint."[1] This disease usually begins in youth. A bunion is apt to form, and the joint may be dislocated. The *treatment* is excision of the joint or amputation.

XXI. DISEASES AND INJURIES OF NERVES.

1. Diseases of Nerves.

Neuritis, or **inflammation of a nerve**, may be limited or be widely distributed (multiple neuritis). The first-mentioned form will here be considered. The *causes* of neuritis are traumatism, wounds, over-action of muscles, gout, rheumatism, syphilis, fevers, and alcohol.

Symptoms.—The symptoms of neuritis are as follows: Excessive pain, usually intermittent, in the area of nerve-distribution. The pain is worse at night, is aggravated by motion and pressure, and occasionally diffuses to adjacent nerve-areas or awakens sympathetic pains in the opposite side of the body. The nerve is very tender. The area of nerve-distribution feels numb and is often swollen. Early in the case the skin is hyperæsthetic; later it may become anæsthetic. The muscles atrophy and present the reactions of degeneration; that is, the muscles first ceases to respond to *rapidly*-interrupted, and next to *slowly*-interrupted, faradic currents; faradic excitability diminishes, but galvanic excitability increases. When, in neuritis, faradism produces no contraction, a slowly-interrupted galvanic current which is so weak that it would produce no movement in the healthy muscles causes marked response in the degenerated muscles. In health the most vigorous contraction is obtained by closing with the — pole; in degenerated muscles the most vigorous contraction is obtained by closing with the + pole.

[1] *American Text-book of Surgery.*

When voluntary power returns galvanic excitability declines, but power is often nearly restored before faradic excitability becomes manifest (Buzzard).

Treatment.—The treatment of neuritis consists of rest upon splints, ice-bags early in the case, and hot-water bags later. Massage and electricity must be used to antagonize degeneration. Deep injections of chloroform may allay pain. Treat the patient's general health, especially any constitutional disease or causative diathesis. In some cases nerve-stretching is advisable.

Neuralgia is manifested by violent paroxysmal pain in the trajectory of a nerve. This disease belongs chiefly to the physician, except in very bad cases. Neuralgia of stumps and scars belongs to the surgeon, and is due to neuromata, or entanglement of nerve-filaments in a cicatrix. Tic douloureux and other intractable neuralgias may require severe operations.

Treatment of Neuralgia of Stumps.—Excise the scar; find the bulbous end of the nerve and cut it off. In some cases re-amputation is performed. In entanglement of a nerve in a scar, remove a portion of the nerve above the scar.

2. Wounds and Injuries of Nerves.

Section of Nerves (as from an incised wound).—In nerve-section the entire peripheral portion of the nerve degenerates and ceases structurally to be a nerve in a few weeks, but after many months, or even after years, the nerve again regenerates —with difficulty, if union of the ends has not taken place, with much greater ease if the ends have united. The proximal end only suffers in the portion immediately adjacent to the section; it degenerates, but rapidly regenerates, and a bulb or enlargement composed of fibrous tissue and small nerve-fibres forms just above the line of section; this bulb adheres to the perineural tissues. Union of a divided nerve is brought

about by the projection of an axis-cylinder from each end and the fusion of these cylinders. The nearer the two ends are to each other, the better is the chance of union.

Symptoms.—Pronounced changes occur in the trajectory of a divided nerve. The muscles degenerate, atrophy and shorten, and show the reactions of degeneration. When union of the nerve occurs the muscles are restored to a normal condition. If the nerve contains sensory fibres, complete anæsthesia (to touch, pain, and temperature) usually follows its division, but if a part is supplied by another nerve as well as by the divided one, anæsthesia may not be complete. Trophic changes arise in the paralyzed parts. Among these changes are muscular atrophy, glossy skin, cutaneous eruptions, ulcers, dry gangrene, painless felons, falling of the hair, brittleness, furrowing, or casting off of the nails, joint-inflammations, and ankylosis. Immediately after nerve-section vaso-motor paralysis comes on, and for a few days the paralyzed part presents a temperature higher than normal. The diagnosis as to which nerve is cut depends upon a study of the distribution of paralysis and anæsthesia.[1]

Treatment.—In all recent cases of nerve-section, suture the ends. If the patient is not seen until long after the accident, incise and apply sutures (secondary sutures); if the nerve cannot be found, extend the incision, find the trunk above and trace it down, and find the trunk below and follow it up. Even after primary suture loss of function is bound to occur for a time. After secondary suture sensation may return in a few days, but it may not return until after a much longer period; in any case muscular function is not restored for months. In partial section of a nerve the ends should be sutured.

Pressure upon nerves may arise from callus, scars, pressure of a dislocated bone or a tumor, or pressure from an

[1] See Bowlby on *Injuries of Nerves.*

external body. The *symptoms* may be anæsthetic, paralytic, and trophic. The *treatment* is as follows: Remove the cause (reduce a dislocated bone, chisel away callus, excise a scar, etc.); then employ massage, douches, and electricity.

Contusion of Nerves.—The *symptoms* of contusion of nerves may be identical with those of section. Sensation or motion, or both, may be lost. The case may get well in a short time, or the nerve may degenerate as after section. The *treatment* at first is rest, and later electricity, massage, frictions, and the douche.

Punctured Wounds of Nerves.—The *symptoms* of punctured wounds of nerves may be partly irritative (hyperæsthesia, acute pain, and muscular spasm) and partly paralytic (anæsthesia, muscular wasting, and paralysis). The *treatment* is the same as that for contusion.

3. Operations upon Nerves.

Neurorrhaphy, or Nerve-suture.—When a nerve is completely or partially divided by accident, it should be sutured. The instruments required are an Esmarch apparatus, a scalpel, blunt hooks, dissecting-forceps, hæmostatic forceps, curved needles or sewing-needles, a needle-holder, and catgut or kangaroo tendon. In primary suture render the part bloodless and aseptic. Enlarge the incision if necessary. If the ends can readily be approximated, pass two or three sutures through both the nerve and its sheath and tie them (Fig. 120). If the ends cannot be approximated, stretch each end and then suture. Remove the Esmarch band, arrest bleeding, suture the wound, dress antiseptically, and put the part in a relaxed position on a splint. After union of the wound remove the splint and use massage, frictions, electricity, and the douche. The operation in some instances fails,

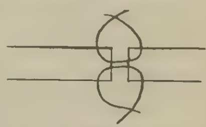


Fig. 120.—Nerve-suture.

but in many cases succeeds. In some few cases sensation returns in a few days, but in most cases does not return for many weeks or months. Sensation is restored before motor power. *Secondary suture* is performed upon cases long after division of a nerve. The part is rendered aseptic and bloodless; an incision is made; the bulbous proximal end is easily found and loosened from its adhesions; the shrunken distal end is sought for and loosened up (it may be necessary to expose the nerve below the wound and trace its trunk upward); the entire bulb of the proximal end is cut off; about one-quarter of an inch of the distal end is removed (Keen); each end is stretched, and the ends are approximated and sewn together. If even stretching does not permit of approximation, adopt one of Bowlby's expedients (Fig. 121) or graft a bit of nerve from a recently-amputated limb or from a lower animal (it makes no difference as to whether the grafted nerve were motor, sensory, or mixed). Von Bergmann suggests shortening the limb by excising a piece of bone.

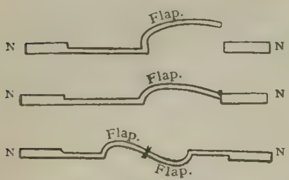


FIG. 121.—Suture of a Nerve by Splitting the Ends (Beach).

Neurectasy, Neurotomy, and Neurectomy.—*Neurectasy*, or nerve-stretching, may be applied to motor, sensory, or mixed nerves. A nerve can be stretched about one-twentieth of its length (Vogt). Neurectasy has been employed for neuralgia, neuritis, muscular spasm, hyperæsthesia, anæsthesia, painful ulcer, and the pains of locomotor ataxia. The operation, which was once the fashion, seems to benefit some cases, but it is not now thought so highly of as formerly. The incision for neurectasy is identical with the incision for neurectomy or neurotomy of the same nerve. *Neurotomy*, or section of a nerve, is only performed upon small and purely sensory nerves. It is performed chiefly for peripheral

neuralgia or for some other painful malady. *Neurectomy*, or excision of a portion of a nerve-trunk, is only applicable to sensory nerves and to painful affections.

Stretching of the Sciatic Nerve.—Some surgeons stretch the sciatic nerve by anæsthetizing the patient and holding the leg and thigh in line, strong flexion being made upon the hip, the entire lower extremity being used as a lever (Keen). This method, which has caused death, inflicts needless damage, and the operative plan is safer and better. The instruments required are a scalpel, hæmostatic forceps, dissecting forceps, an Allis dissector, retractors, and a scale with a handle and a hook. The patient lies prone, the thighs and legs being extended. An incision four inches in length is made a little external to the middle of the thigh, and going at once through the deep fascia; the biceps is found and is drawn outward; the nerve is found between the retracted biceps on the outside and the semitendinosus on the inside, resting upon the adductor magnus muscle. The nerve, which is caught up by the finger, is first pulled down from the spine and then up from the periphery, and finally the hook of the scale is inserted beneath the trunk and the nerve is stretched to the extent of forty pounds. Very rarely is a single ligature needed. The wound is sutured and dressed. If the incision is made higher up, just below the gluteo-femoral crease, the sciatic nerve will be found just by the outer border of the biceps.

Neurectomy of the Infraorbital Nerve.—The instruments required in this operation are a scalpel, dissecting-forceps, aneurysm-needle, hæmostatic forceps, blunt hooks, an Allis dissector, and metal retractors. The patient lies upon his back, the head being a little raised by pillows. The surgeon stands to the outside of, and faces, the patient. A curved incision one and a half inches long is made below the lower border of the orbit. The nerve lies in a line

dropped from the supraorbital notch to between the two lower bicuspid teeth. The nerve is found upon the levator labii superioris muscle, and a piece of silk is passed under the nerve by an aneurysm-needle and firmly fastened. The upper border of the incision is drawn upward; the periosteum of the floor of the orbit is elevated and held by a retractor; the roof of the infraorbital canal is broken through; the nerve is picked up far back with the blunt hook and is divided with scissors, and the entire nerve is drawn out by making traction upon the silk. The bleeding in the orbit is checked by pressure. The wound is stitched without drainage.

Neurectomy of the Supraorbital Nerve.—In this operation, shave off the eyebrow. The instruments required and the position of the patient are as for the operation upon the infraorbital nerve. A curved incision one inch long discloses the nerve as it emerges from the supraorbital notch or foramen at the junction of the inner and middle thirds of the eyebrow. The nerve is pulled forward and cut off above and below.

XXII. DISEASES AND INJURIES OF THE HEAD.

1. Diseases of the Head.

In approaching cases of brain disorder, first endeavor to locate the seat of the trouble; next, to ascertain the nature of the lesion; and finally, to determine the best plan of treatment, operative or otherwise. In all operations upon the brain the surgeon must be able to determine accurately the situations of certain fissures and convolutions, the finding of the situations of these convolutions and fissures comprising the science of cranio-cerebral topography.

The regional terms used in cranio-cerebral topography are derived from Broca (Fig. 122). The fissures and convolutions of the brain are shown in Figures 123, 124, and 125. The *fissure of Bichat* is marked by a line on each side drawn

from the inion to the external auditory process. A line from the glabella to the inion overlies the median fissure and the superior longitudinal sinus. The *fissure of Rolando* begins in the median line, half an inch posterior to the middle of the distance between the inion and glabella (Keen). This fissure runs downward and forward at an angle of 67° for a distance of three and three-eighths inches. Chiene finds the fissure of Rolando by the following method: He takes

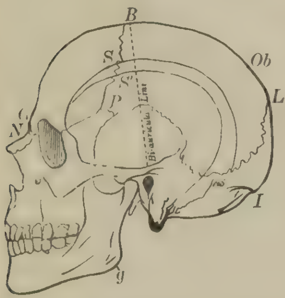


FIG. 122.—Skull showing the Points named by Broca: *As*, asterion (junction of the occipital, parietal, and temporal bones); Basion, middle of anterior wall of foramen magnum; *B*, bregma (junction of the sagittal and coronal sutures); *G*, ophryon (on a level with the superior border of the eyebrows, and corresponding nearly to the glabella, the smooth swelling between the eyebrows); *g*, gonion (angle of the lower jaw); *I*, inion (external occipital protuberance); *L*, lambda (junction of sagittal and lambdoidal sutures); *N*, nasion (junction of the nasal and frontal); *Ob*, obelion (the sagittal suture between the parietal foramina); *P*, pterion (point of junction of great wing of sphenoid and the frontal, parietal, and squamous bones. This may be H-shaped or K-shaped, or "retourné," in which the frontal and temporal just touch); *S*, stephanion (or, better, the superior stephanion, intersection of ridge for temporal fascia and coronal suture); *S'*, inferior stephanion (intersection of ridge for temporal muscle and coronal suture).

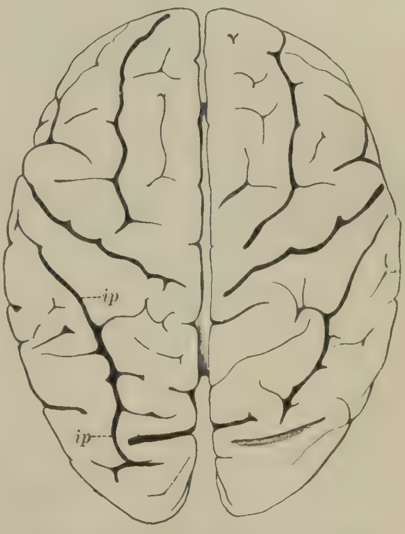


FIG. 123.—View of the Brain from Above (Ecker).

a square piece of paper and folds it into a triangle (Fig. 126, 1); the angle B A C of this triangle is 45°; the edge D A is folded back on the dotted line A E; the angle D A E equals half of 45°, or 22.5°, and the angle C A E equals the same (Fig. 126, 2); unfold the paper in the line C A; in the

figure thus formed BAC = 45° and EAC = 22.5°; EAB = 67.5°, which is the angle desired. Place the point A in the midline of the head, over the point of origin of the Rolandic fissure; the side A B is laid along the middle line of the head, and the line A E corresponds to the fissure of Rolando.[1] Horsley determines the situation of the Rolandic fissure by the use of his metal cyrtometer (Fig. 127). He places the point marked zero over the inio-glabellar line and midway between the inion and the glabella. To find the

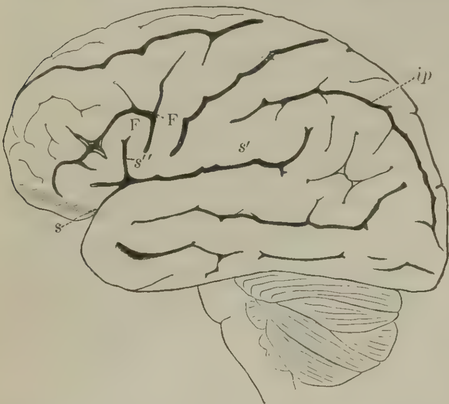


FIG. 124.—Outer Surface of the Left Hemisphere of the Brain (Ecker).

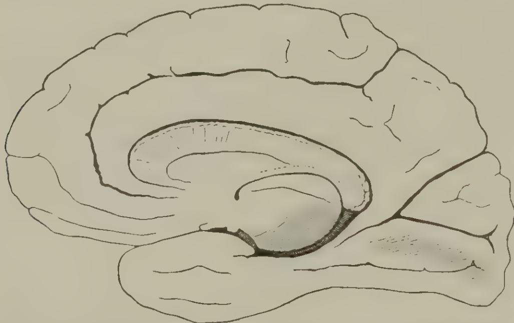


FIG. 125.—Inner Surface of the Right Hemisphere of the Brain (Ecker).

fissure of Sylvius (Fig. 124, *S*, *s'*, *s''*), draw a line from the external angular process to the occipital protuberance. The fissure of Sylvius begins on this line one and one-eighth

[1] *American Text-book of Surgery.*

inches behind the external angular process; the main branch of the fissure runs toward the parietal eminence; the ascending branch of the fissure corresponds to the squamoso-sphenoidal suture, and continues upward in the same line half an inch above the suture. The *precentral sulcus* (Fig. 124, F) limits anteriorly the ascending frontal

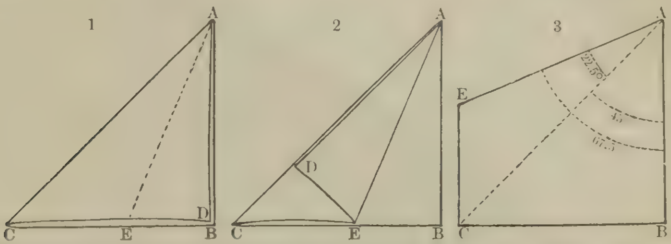


FIG. 126.—Chiene's Method of Fixing Position of the Rolandic Fissure (*Am. Text-book of Surgery*).

convolution; it runs parallel with and just behind the coronal suture, and a finger's breadth in front of the fissure of Rolando. The *intraparietal fissure* (Figs. 123, 124, *ip*) limits the motor region posteriorly. It begins opposite the junction of the lower and middle thirds of the fissure of Rolando,

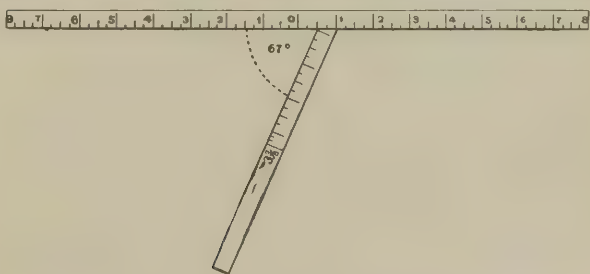


FIG. 127.—Horsley's Cyrtometer.

passes upward in a line parallel with the longitudinal fissure and midway between the Rolandic fissure and the parietal eminence, passes by the parieto-occipital fissure, and downward and backward into the occipital lobe (Keen). The motor

areas, which on the outer surface are adjacent to the fissure of Rolando, are shown in Figures 123 and 124. The superior longitudinal sinus is overlaid by a line from the inion to the glabella. The lateral sinus is indicated by a line running from the occipital protuberance horizontally outward to a point one inch posterior to the external auditory meatus, and from this point by a second line dropped to the mastoid process. The supra-meatal triangle of Macewen is bounded by the posterior root of the zygoma, the posterior bony wall of the auditory meatus, and a line joining the two. Figure 128 shows clearly the main points of cranio-cerebral topography, obtained by methods approved by many scientists.

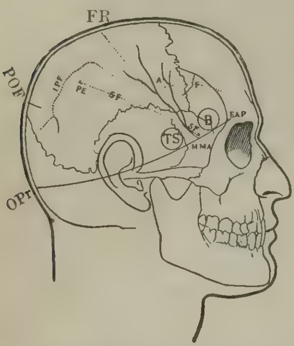


Fig. 128.—Head, Skull, and Cerebral Fissures (adapted from Marshall by Hare): B corresponds to Broca's convolution; EAP, external angular process; FR, fissure of Rolando; IF, inferior frontal sulcus; IPF, intraparietal sulcus; MMA, middle meningeal artery; OPr, occipital protuberance; PE, parietal eminence; POF, parieto-occipital fissure; SF, Sylvian fissure; A, its ascending limb; TS, tip of temporo-sphenoidal lobe. The pterion (to the left of B) is the region where three sutures meet, viz., those bounding the great wing of the sphenoid where it joins the frontal, parietal, and temporal bones.

Diseases of the Scalp.—The scalp is composed of skin, subcutaneous fat, and the occipito-frontalis muscle and aponeurosis. The scalp is liable to inflammation from various causes, and to other diseases, namely: tumors, cysts, warts, moles (local cutaneous hypertrophies), cirsoid aneurysm (p. 231), nævi, and lupus. *Abscesses of the scalp* are common. If an abscess forms beneath the pericranium, the pus diffuses over the area of one bone, being limited by the attachment of the pericranium in the sutures. If an abscess forms in the tissue between the occipito-frontalis and the pericranium, it is widely diffused. Treves calls this subaponeurotic connective tissue "the dangerous area." Abscess of the subcutaneous tissue is apt to be limited

because of the great amount of fibrous tissue. Abscess is treated by instant incision at the most dependent part, antiseptic irrigation, and drainage.

Diseases and Malformations of the Bones of the Skull.—The bones of the skull are liable to caries, necrosis, osteitis, periostitis, atrophy, hypertrophy, tumors, etc. (See *Diseases of Bones.*)

Microcephalus.—By microcephalus is meant unnatural smallness of the head due to imperfect development. It is a cause or a frequent associate of idiocy. A child may be born with a skull completely ossified even at the fontanelles, or the ossification may become complete soon after birth. In microcephalus the face is apt to be fairly well developed; the jaws are prominent; the forehead is flat; the cranium and brain are small; the convolutions of the brain are simpler than is natural; there is apt to be marked asymmetry of the two sides of the brain; internal hydrocephalus may exist; areas of sclerosis and atrophy are common; porencephaly is not unusual. Some patients have perfect motor power; others are slow and inco-ordinate. Epilepsy, chorea, and athetosis frequently complicate the case.

Treatment.—Skilled training in a school for the feeble-minded or in an institution for idiots is necessary in treating microcephalus. Some surgeons advise that first a craniectomy be performed (see *Operations on Skull and Brain*). The late Prof. Agnew, taking the view that the growth of soft parts moulds hard parts, and that the fault is with the brain, and not with the skull, maintained that the surgeon might as well cut a piece out of a turtle's shell to permit growth of the turtle as to cut a piece out of the skull to permit growth of the brain. Prof. Keen says, "While there is no doubt that, as a rule, the growth of the encasing hard parts is dominated by the growth of the contained soft parts, yet it is very possible that while a healthy brain may over-

come the normal resistance of the skull, a brain with feeble powers of development may be arrested in its growth by the slight resistance offered by the skull." Prof. Keen further says, "Whether the operation will stand the test of time cannot yet be determined, but considerable initial improvement has followed in a number of cases."

Diseases and Malformations Involving the Brain.—**Meningocele** is a congenital protrusion of the cerebral membranes through a bony aperture, the sac containing some extra-cerebral fluid. Meningocele feels and looks like a cyst (is translucent and fluctuates); it does not usually pulsate, it has a small base, it becomes tense on forcible expiration, and it may be reduced.

Encephalocele is a congenital protrusion not only of membranes, but also of a portion of the brain as well, the sac containing some extra-cerebral fluid. Encephalocele is small, opaque, does not fluctuate, has a broad base, does pulsate, becomes tense on forced expiration, and attempts at reduction cause pressure-symptoms.

Hydrencephalocele is a congenital protrusion of membranes and brain-substance, the interior of the mass communicating with the ventricles and containing ventricular fluid. This is the most frequent and the most dangerous form. Hydrencephalocele is larger than a meningocele, is translucent, fluctuates, rarely pulsates, is pedunculated, is rendered a little tense on forced expiration, and cannot be reduced.[1]

Treatment.—For hydrencephalocele nothing can be done, and early death is inevitable. In rare instances an encephalocele is converted into a meningocele, and the bony aperture closes, thus bringing about a cure. Among the expedients for treating meningocele and encephalocele are electrolysis, injection of Morton's fluid (gr. x of iodine,

[1] *American Text-book of Surgery.*

gr. xxx of iodide of potassium, ℥j of glycerin), pressure, and excision.

Hydrocephalus.—In *external* hydrocephalus the fluid is between the membranes and the brain; in *internal* hydrocephalus the fluid is in the ventricles. Hydrocephalus may be *acute* or *chronic*, *congenital* or *acquired*.

Acute hydrocephalus, which results from meningitis (usually from tubercular meningitis), is usually internal, but may be external. The symptoms are headache, elevated temperature, delirium, stupor, convulsions, paralysis, and choked disk.

Treatment of acute hydrocephalus is of no avail. Tapping of the ventricles may be tried.

Chronic hydrocephalus is usually congenital. The cranium enlarges enormously and the bones of the skull are widely separated. The broad forehead overhangs the eyes. The child is an idiot, and very often does not learn to walk or to talk. Convulsions and palsies are common, and blindness is frequent. Such children usually die young.

The *treatment* of chronic hydrocephalus is rarely of much avail. Pressure by strapping with adhesive plaster has been tried. Tapping through a fontanelle may be performed by means of a trocar (only ℥ij or ℥iij being drawn at a time). If much fluid is drawn, the head must be strapped afterward. If the skull ossifies, the lateral ventricles may be tapped. It has been proposed to drain by tapping the theca of the spinal cord (Quincke).

2. Injuries of the Head.

Cephalhæmatoma (caput succedaneum), which is a collection of bloody serum under the scalp of a new-born child, results from the pressure of labor. No treatment is required.

Scalp-wounds are treated as are other wounds. A large

piece of scalp with only a narrow pedicle may not slough; hence try to save any piece that has an attachment. Always shave a wide area and disinfect the wound thoroughly. Stitch the wound with silkworm gut. If drainage is required, use a few strands of horsehair.

Contusions of the Head.—Scalp-swelling from hemorrhage is usually considerable. The patient may be stunned or dazed. The swelling of hæmatoma must not be mistaken for *fracture* with depression. In hæmatoma there is a central depression, hard pressure finds bone on a level with the general contour of the bone, and the margin of a hæmatoma is circular, is not quite hard, and is elevated above the general contour. In depressed fracture the edge is on a level with or below the level of the general bony contour, and the margin is sharp and irregular. The *treatment* is by means of pressure and the use of lead-water and laudanum. If suppuration arises, at once incise.

Concussion or Laceration of the Brain.—Prof. Keen says that there may be slight brain-injuries which may properly be called "concussions," but it is better to consider concussion as synonymous with laceration of the brain. The cause of concussion is violent force, either direct (as a blow upon the head) or indirect (as a fall upon the buttocks). This force shakes, oscillates, or jars the brain and ruptures vascular twigs, large vessels, or even the membranes. In the slighter ruptures concussion only exists; in the severe ruptures compression soon arises.

Symptoms.—In a mild case of brain-concussion the patient may or may not fall; his face is pale; he feels weak, giddy, nauseated, and confused; he often vomits, but soon reacts. In a severe case he lies with complete muscular relaxation, cold extremities, pale and cold skin, shallow and quiet respiration, frequent, small, soft, and irregular pulse (pulse may not be detectable), and fluttering heart. He seems

unconscious, but can be roused to monosyllabic response by shouting, pinching, or holding a bright light near his face. The urine and feces are often passed involuntarily. The pupils may be unaltered, may be dilated or contracted, or may be equal or unequal, but in any case they will react to light. No paralysis exists. The temperature at first is subnormal. In a severe cortical laceration there will be twitchings or even general convulsions, or the patient will lie curled up with limbs flexed and eyelids shut, and will resist all attempts to open his eyes or mouth or to move his limbs (A. Pearce Gould). Erichsen called this condition "cerebral irritability." As the patient reacts he will most probably vomit. Within twenty-four hours he usually improves, but is feverish and complains of headache and lassitude. After concussion a man's whole nature may change: he may develop hysteria, insanity, or epilepsy, and in many cases there is complaint for a long time of headache, insomnia, low spirits, and lassitude. If the patient in concussion recedes from, instead of advancing toward, recovery, coma will set in or inflammation will develop. Dr. Keen states that the prognosis is always uncertain. Any concussion producing unconsciousness is a serious injury, because considerable laceration must have occurred.

Treatment.—In treating brain-concussion, bring about reaction by the administration of aromatic spirits of ammonia (no alcohol), by surrounding the patient (who lies in bed without a pillow) with hot bottles, by the application of mustard over the heart, and by the administration of hot coffee. Place the patient in bed in a quiet room, and watch him. For some days or for some weeks, according to the case, insist on an easy life. Give a plain diet containing a minimum of meat, administer an occasional purgative, and secure sleep. If inflammation arises, some surgeons will not trephine, but others, especially if the damage seems to

be localized, incise the scalp and inspect the bone. If a fracture is discovered and the symptoms are serious, they perform an exploratory trephining, open the dura, and secure drainage for inflammatory products.

In many severe contusions the surgeon should at once incise the scalp and inspect the bone. For many weeks after a severe concussion a patient must be kept away from business and be watched because of the possibility of an abscess of the brain arising.

Compression of the Brain.—The *causes* of brain-compression are hemorrhage, depressed fracture, tumor, inflammatory exudate, pus, and foreign bodies.

Symptoms.—In brain-compression complete coma exists without voluntary movement. The skin is hot and perspiring; the respirations are slow and stertorous and the cheeks flap during expiration; the pulse is slow and full, and may be irregular; the pupils are dilated, and do not respond to light; there is usually retention of urine, and often incontinence of feces; paralysis exists, which may be very limited (monoplegia), may be of one side (hemiplegia), or may be general. In hemorrhage into the interior of the brain the unconsciousness is immediate or nearly so. In bleeding from the middle meningeal artery a period of consciousness intervenes between the injury and the coma, in which period blood collects. In compression from depressed fracture or from a foreign body the symptoms usually come on at once, but they may be deferred for some hours. Compression from inflammation or pus begins gradually after a considerable time has elapsed.

A *diagnosis* must be made between coma due to brain-injury and the comatose conditions of apoplexy, uræmia, opium-poisoning, and alcoholic intoxication. In hospital practice cases of unconsciousness without a known history are frequent. In attempting this diagnosis, examine care-

fully for any evidence of traumatism, and inquire as to how and where the patient was found, if any fit occurred, and if a bottle or a pill-box was found near by or in the pockets, which also examine. Smell the breath to notice alcohol or opium, but always remember that a man may be stricken with apoplexy while being drunk, and may fracture his skull by falling when under the influence of opium or of alcohol. Draw the urine with the catheter if any water is in the bladder, examine the urine for albumin and alcohol, and take the specific gravity. In doubtful cases of coma, use the ophthalmoscope. In *post-epileptic coma* the temperature is never below normal, there are no unilateral symptoms, the condition resembles sleep, and the patient can be aroused. *Hysterical coma* occurs in boys and women; there are no objective symptoms, and the patient, though swallowing what is put into his mouth, cannot be roused (Gowers). In *uræmia*, besides the condition of the urine (and always remember that a person with albuminuria is apt to develop apoplexy), there is a persistent subnormal temperature, and convulsions are prone to occur. There is œdema of the legs, and paralysis and stertor are absent. In *apoplexy* hemiplegia exists, and the initial temperature is for a short time subnormal. A single convulsion may have ushered in the case. *Alcoholic unconsciousness* is often diagnosticated when apoplexy really exists. A man will smell of alcohol who has had one drink, but one drink will not produce coma; hence the smell of alcohol is not conclusive. In any case of doubt some hours of watching will clear up the diagnosis. Regard a doubtful case as serious until the truth is clear. In *opium-poisoning* the pupils are contracted to a pin-point, the respirations are usually slow, shallow, and quiet, but may be stertorous, but there is no paralysis. Always remember that hemorrhage into the pons will produce pin-point pupils, but it also causes paralysis (crossed paralysis if in the lower

half of the pons) and high temperature with sweating. In opium-poisoning the temperature is subnormal. In *diabetic coma* the pupils will react to a very bright light, the temperature is subnormal, and the breath and the urine smell like chloroform.

Treatment.—The treatment of brain-compression depends on the cause. Hemorrhage (extradural or subdural) requires trephining and arrest of bleeding; coma from depressed fracture demands trephining and elevation; foreign bodies must be removed; abscesses must be evacuated; some tumors are to be removed.

Intracranial hemorrhage may be either *spontaneous* or *traumatic*. In the vast majority of instances spontaneous hemorrhage comes from the lenticulo-striate artery (Charcot's artery of cerebral hemorrhage), and produces apoplexy, a disease belonging to the physician except in some ingravescent cases, for which ligation of the carotid on the same side as the rupture is indicated. Traumatism during delivery is a not unusual cause of hemorrhage from the middle meningeal artery (Richardière). A traumatic hemorrhage may take place (1) between the bone and the dura (*extradural*); (2) between the dura and the brain (*subdural*); and (3) in the brain-substance (*cerebral*).

(1) **Extradural hemorrhage** arises from the middle meningeal or, more often, from one of its branches. It is usually, but not always, accompanied by fracture; in fact, in some cases not even a bruise can be found. The accident may or may not cause temporary unconsciousness, but even if it does, from this unconsciousness the patient almost always reacts, and there is a *distinct period of consciousness* between the accident and the lasting coma, the coma being due to pressure from a continually increasing mass of extravasated blood. If the main trunk or a large branch is ruptured, the period of consciousness is short; if a small branch is rup-

tured, the period of consciousness is prolonged for hours or perhaps for days. The other signs of this condition are paralysis of the side opposite the blood-clot (not necessarily of the side opposite the injury, for the artery may rupture from contre-coup on the uninjured side); this paralysis is apt at first to be localized, but it gradually and progressively widens its domain. If the clot extends toward the base, the pupil on the same side as the clot ceases to react and dilate, and if it be the left side, aphasia is noted. The pulse becomes frequent; the breathing becomes stertorous; the temperature rises, that of the paralyzed side exceeding that of the sound side; and in a compound fracture the pressure of escaping blood may force brain-matter out of the wound (Keen).

Treatment.—In treating extradural hemorrhage, localize the clot, not by the seat of the wound or contusion, but entirely by the symptoms. Trephine one and one-fourth inches back of the external angular process, at the level of the upper border of the orbit (Krönlein). If this incision does not show the clot, trephine again at the level of the upper border of the orbit and just below the parietal eminence. The first incision gives access to the trunk and to the anterior branch; the second incision exposes the posterior branch. If signs indicate that the clot is travelling to the base, the trephine should be used half an inch lower than the first indicated point. Proceed to arrest bleeding as directed on page 252, and always drain.

(2) **Subdural hemorrhage** is usually due to depressed fracture and rupture of the middle cerebral artery or of a number of small vessels. The *symptoms* are identical with those of extradural bleeding.

The *treatment* is trephining at the first hemorrhagic point, enlarging the opening with a rongeur upward and backward, opening the dura, turning out the clot, ligating the

bleeding point, elevating any depression of bone, draining, and stitching the dura with catgut. Hemorrhage from internal pachymeningitis requires the same treatment.

(3) **Cerebral Hemorrhage.**—The *symptoms* of cerebral hemorrhage are identical with those of apoplexy. The *treatment* is the same as that for apoplexy, except in ingravescent cases, when the common carotid on the same side as the clot should be ligated.

Rupture of a sinus usually arises from compound fracture or during a brain-operation. The *treatment*, if the rupture happens from fracture, is trephining. Enlarge the opening by the rongeur, pack with *one large piece* of iodoform gauze, or catch the rent with hæmostatic forceps, leaving them in place for three or four days, or apply a lateral ligature. Elevate depressed bone. In rupture during an operation, control hemorrhage by packing.

Fractures of the skull may be *simple*, *compound*, *depressed*, *non-depressed*, or *punctured*. They are divided into fractures of the *vault*, usually due to direct force, and fractures of the *base*, due to extension of fractures of the vault, to indirect violence (a fall upon the feet, the buttocks, or the vault), to forcing of the condyles of the lower jaw against or through the base, or to foreign bodies breaking through the orbit or the roof of the nostrils. Fracture by contre-coup, which occurs on the side opposite the application of the violence, is very rare. Fractures of the skull are uncommon in early youth, but they are much more frequent in the aged. Usually the entire thickness of the bone is fractured, but either the outer or the inner table may be broken alone. In complete fractures the inner table is broken more extensively than is the outer table, because the inner table is the more brittle, because the force diffuses, and also, as Agnew taught, because the inner table is part of a smaller curve than is the outer table, and violence forces bone-elements

together at the outer table, but tears them asunder at the inner table (Figs. 129, 130).

FIG. 129.—Section of Outer and Inner Tables, with two parallel lines (after Agnew).

FIG. 130.—Greater Yielding of the Inner Table than of the Outer after the Application of Violence (after Agnew).

Fractures of the Vault.—A fracture of the vault of the skull may be simple and undepressed, or may be depressed, compound, or comminuted. A mere crack may exist in a bone, and if a rent exists in the soft parts, a bit of dirt or a hair may be caught in the crack. Fractures of the vault arise from direct force. A fissure may escape recognition, although in some cases percussion gives a "cracked-pot" sound. Any considerable depression can be detected. In a simple fracture occasionally the cerebro-spinal fluid collects under the scalp and forms a tumor which pulsates and becomes tense on forcible expiration. Compound fractures can be readily recognized, but Keen cautions the surgeon not to mistake a suture, a Wormian bone, or a tear in the pericranium for a fracture. A fissured fracture is marked by a dark line of blood which *sponging will not remove.* Fracture of the inner table alone can be suspected only (Keen). The prognosis of fractures of the vault depends upon the extent of brain-injury rather than upon the extent of bone-injury. Simple fractures unite by bone; compound fractures with loss of bone, by fibrous tissue. The dangers may be *immediate* (brain-injury and septic inflammation) or be *distant* (epilepsy, insanity, and persistent headache).

Treatment.—A simple fracture without depression and

without brain-symptoms is treated expectantly (by rest, quiet, low diet, purgation, moderate elevation of and cold to the head, and arterial sedatives). A simple fracture with moderate depression and without cerebral symptoms is treated expectantly, and so also is a simple fracture in which symptoms existed but are abating. Simple fracture with marked depression requires immediate trephining, even when brain-symptoms are absent. Trephining in these cases often prevents disastrous consequences, and is known as "preventive trephining" (Agnew, Keen, White, Horsley, Macewen). In all compound fractures, shave and asepticize the entire scalp, enlarge the incision, and explore the bone. If a fissure exists, it must be asepticized, and if a hair or other foreign body is found in it, in order to effect removal and secure asepsis the outer table of the skull must be cut away with a chisel, the fissure being thus converted into a broad groove. In a compound fracture with much depression, trephine, elevate, and irrigate. In any fracture, trephine if distinct symptoms exist. In punctured wounds of the brain (punctured fractures), *always* trephine, open the dura, and disinfect (Keen). In any case of fracture of the vault where trephining has been performed, do not hesitate, if it seems expedient, to open the dura and examine the brain.

Fractures of the Base.—A fracture of the base of the skull may exist in only one of the three fossæ, in two of them, or it may involve all. The middle fossa is oftenest involved. Fracture of the posterior fossa is the most fatal. These fractures may be due to direct violence, to indirect force, and to extension of a fracture of the vault. Extension from the vault is always by the shortest route. Fracture by direct violence may arise from the penetration of the nasal roof, the orbital roof, or the pharyngeal roof by a foreign body. The posterior fossa may suffer from a fracture by direct violence applied to the neck. Fractures by indirect

force may arise from blows upon the frontal bone (the orbital portion of the frontal or the cribriform process of the ethmoid breaking), from falls upon the chin (the condyle of the jaw breaking the middle fossa), or from falls upon the buttocks, the knees, or the feet (fracture occurring in the posterior fossa). The base is very rarely broken by contre-coup (Treves).

Symptoms.—In fractures of the base of the skull blood and cerebro-spinal fluid are apt to flow externally. In fractures of the anterior fossa blood may run from the nose, its source being the laceration of the mucous membrane or the vessels of the dura, the fracture being compound. Cerebro-spinal fluid only appears when the mucous membrane, the dura, and the arachnoid are each lacerated (Treves). In fractures of the anterior fossa blood is apt to flow into the orbit, producing subconjunctival ecchymosis, and some blood is often swallowed and vomited. In fractures of the middle fossa blood flows from the ear through a tear in the tympanum, its source being the vessels of the tympanum, the meningeal vessels, or a sinus. Blood may flow through the Eustachian tube and come from the nose, may be spit up, or may be swallowed and vomited. In many cases a quantity of cerebro-spinal fluid flows from the ear, the discharge being increased by expiratory effort and a position which favors gravity. The cerebro-spinal fluid must not be confused with either blood-serum or liquor Cotunnii. The cerebro-spinal fluid is always present in large amount; the liquor Cotunnii can only be present in minute amount. Blood-serum is highly albuminous; cerebro-spinal fluid is a serous fluid of very low specific gravity, never shows more than a trace of albumin, and contains considerable chloride of sodium and in some instances sugar, which, when present, reacts to Trommer's and to Moore's test, but does not reflect polarized light nor ferment with yeast (Keetley, from Collins). Treves

states[1] that cerebro-spinal fluid cannot flow from the ear in fractures of the middle fossa unless (1) the line of fracture crosses the internal meatus, (2) unless the prolongation of the membranes into the meatus is torn, (3) unless a communication exists between the internal ear and tympanum, and (4) unless the drum-membrane is torn. Profuse serous discharge may flow from the ear after an injury without fracture when the drum is ruptured, the fluid coming from the cells of the mastoid. It must be understood that fracture of the base may exist when there is no flow of blood or of serous fluid (when the drum is not lacerated). A fracture of the middle fossa is usually compound, made so, even when the drum is not ruptured, by the Eustachian tube. In fracture of the posterior fossa blood accumulates beneath the deep fascia and produces discoloration in the line of the posterior auricular artery (Battle's sign), the discoloration first appearing near the tip of the mastoid. Fractures of the base are apt to be associated with paralysis of cranial nerves. Optic neuritis often arises after the first week. Dr. Keen says that in fractures of the base the temperature is subnormal during the shock, rises to 100° or 101°, falls again to a little below normal, and remains normal or subnormal unless there be inflammation or sepsis.

Treatment.—In treating a fracture of the base of the skull, collect any serous discharge and analyze it, and disinfect any cavity involved. In fractures of the middle fossa with ruptured drum, clean the ear mechanically, wash it out with hydrogen peroxide and with a stream of warm corrosive-sublimate solution of a strength of 1 : 2000 (turn the head toward the affected side, so that the mercurial solution will not run down the Eustachian tube), pack with iodoform gauze, and apply an antiseptic dressing. The naso-pharynx must be cleaned and insufflated with iodoform. In fracture

[1] *Applied Anatomy.*

of the orbit the surgeon must disinfect, and if the fracture is punctured, the roof of the orbit must be trephined or be chiseled to permit of disinfection and drainage. In fractures of the middle and anterior fossæ the naso-pharynx must be cleaned. Wash out these cavities often with hot water, next with peroxide of hydrogen, and finally with boracic-acid solution. Insufflate the naso-pharynx with iodoform, and pack the nose with iodoform gauze (Keen, Dennis). In some cases drainage has been obtained from the anterior fossa by breaking down the cribriform plate and introducing a tube through the nostril (Allis), and from the middle fossa by trephining above and behind the external auditory meatus. In a very extensive fracture of the base, besides use of the methods set forth above, the entire head should be shaved and a plaster cap be applied. Cases of fracture of the base must be put into a quiet and darkened room and be kept upon a low diet, sleep being secured and the bowels and bladder being attended to.

Wounds of the brain are produced by violence and by foreign bodies (knives, bullets, etc.). Except when due to penetration of a fontanelle in a child or of a parietal foramen in adults, wounds of the brain are accompanied by fracture of the skull. These wounds are very dangerous: foreign bodies (bone, hair, clothing, etc.) are often lodged in the brain, hemorrhage is usually severe, and sepsis is almost inevitable without proper treatment. These cases are very fatal, though some astonishing recoveries are on record.[1] The *symptoms* of brain-wounds may be slight and long-deferred or may be immediate and overwhelming; they depend upon the site and extent of the injury. Localizing symptoms may exist, and encephalitis with coma is apt to arise. Abscess not unusually follows. In treating wounds

[1] See a most interesting and instructive paper by Dr. Wm. J. Taylor, read before the Academy of Surgery of Philadelphia, and reporting a number of cases.

of the brain, always shave the entire scalp and examine the weapon to see if a piece were broken off. Asepticize, enlarge the wound, trephine, arrest bleeding, elevate any depression, remove foreign bodies, irrigate the wound, suture the dura, drain, and dress.

Gunshot Wounds of the Head.—A *penetrating* wound is one in which the bullet enters the head, but does not emerge; a *perforating* wound is one in which the bullet passes through the head and emerges. The wound of entrance is small; the wound of exit is large. At the wound of entrance the inner table is more extensively fractured; at the wound of exit, the outer table. The *symptoms* of gunshot wounds of the head are similar to those of any other brain-wound, but, as a rule, are more widely diffused.

Treatment.—In treating gunshot wounds of the head, shave and asepticize the whole scalp, disinfect the entire track of the ball, and arrest hemorrhage at the wounds of entrance and exit, using the rongeur to expose the bleeding points. The bullet, if retained, is to be sought for. So place the head that the track of the ball will be vertical, then introduce Fluhrer's aluminium probe and let it find its way by gravity. The probe may find the ball near the wound of entrance, in which case extract the ball with forceps; or the probe may find the ball near the opposite side of the head, in which case make a counter-opening through the bone, at a point the probe would touch if it were pushed entirely across. Take a new and *clean* rubber catheter (No. 9, French), insert a stylet, and carry the catheter through the wound (Keen). Knowing the depth of the ball, it is searched for around the catheter tube as an axis, and when found it is extracted. After extraction, drain the wound by means of a tube. When a counter-opening exists, drain through and through. Girdner's induction-balance may be employed to locate a ball. If the ball cannot be detected,

drain by a tube carried to the depths of the wound. After dressing, always place the head in a position favorable to drainage.

Fungus cerebri (hernia of the brain) rarely contains true brain-substance. It is in most instances a growth from the neuroglia. Hernia cerebri cannot occur if the dura is not opened; it is rare in any case unless the brain was damaged, and is most frequent after septic wounds. In any brain-operation where the dura is opened, suture it; or, if there be a great gap in the dura, cut off a piece of pericranium from the flap, turn its bone-forming surface upward, and stitch this membrane to the dura (Keen). The *evidence* of brain-hernia is a protruding mass which is soft, lobulated, of a dirty-white color, pulsating, painless to the touch, often bleeding, and sometimes discharging cerebro-spinal fluid. In treating brain-hernia, employ antiseptic dressings. Skin-grafting benefits some cases. Pressure is dangerous. Excision by the knife or cautery does no good. After healing, a depression marks the site of the hernia.

Traumatic inflammation of the brain and its membranes is divided into *encephalitis* or *cerebritis*, inflammation of the cerebrum; *cerebellitis*, inflammation of the cerebellum; *meningitis*, inflammation of the meninges; *arachnitis*, inflammation of the arachnoid; *pachymeningitis*, inflammation of the dura; and *leptomeningitis*, inflammation of the arachnoid and pia.

Pachymeningitis.—Inflammation of the external layer of the dura is rare (pachymeningitis externa). It may arise from tumor, caries, necrosis, middle-ear disease, sunstroke, or traumatism. Syphilis is a not unusual cause. The other membranes may become involved. Suppuration may arise, having extended by contiguity from neighboring parts. The *symptoms* of pachymeningitis externa are uncertain. They resemble often those of leptomeningitis. Pressure-symptoms

may arise. Paralysis may or may not exist. If pus forms, the ordinary constitutional symptoms of suppuration arise (high temperature and sweats), not the symptoms of abscess in the brain. In a severe case other membranes become involved. The *treatment* consists in removing the cause (carious bone, pus, middle-ear disease). In pachymeningitis from traumatism, trephine to drain inflammatory products; in a case with localizing symptoms, trephine; in an ordinary case, without pus and with no evidences of traumatism, use wet cups back of the mastoid processes, apply an ice-bag to the head, and purge by means of calomel. Use iodide of potassium in most cases. If sunstroke is the cause, treat accordingly.

Pachymeningitis interna may extend from the pia. The form known as *hæmatoma* of the dura mater, or pachymeningitis interna hæmorrhagica, may arise during infectious diseases (typhoid fever and rheumatism), in persons of the hemorrhagic diathesis, in diseases causing atrophy of the brain, and in chronic diseases of the heart and kidneys. Among the exciting causes are traumatism, inflammation in adjacent parts, and, especially, the abuse of alcohol. In this disease blood is extravasated on the inner surface of the dura. Many observers do not class hemorrhagic pachymeningitis as inflammation, but regard the hemorrhage as primary. The *symptoms* of internal pachymeningitis are very chronic, are not characteristic, and may be absent. They consist usually of persistent headache and apoplectiform attacks with contraction of the pupil, slow pulse, and vomiting. Choked disk is not infrequent, localizing symptoms may be made out, and coma is apt to arise. The *treatment* is the same as that of external pachymeningitis.

Leptomeningitis is a purulent inflammation of the soft membranes of the brain. The pathological changes can be noted in the pia and in the brain-substance. The brain is

œdematous, the pia purulent, the convolutions are flattened, the ventricles are distended with fluid, and hemorrhages occur into the brain-substance. Pus may be localized upon the pia, but it is usually diffused over one hemisphere or over both. This disease may be acute or be chronic, and a severe case is spoken of as encephalitis. One form is tubercular, another is syphilitic. Secondary leptomeningitis is apt to affect the convexity; primary leptomeningitis is apt to affect the base (Hirt).

The *causes* of leptomeningitis are epidemic cerebro-spinal fever, tuberculosis, acute general diseases (pneumonia, typhoid, erysipelas, and rheumatism), bone diseases, traumatisms, middle-ear disease, syphilis, and sunstroke. The tissues of the pia and the cerebro-spinal fluid contain diplococci identical with pneumococci. Hirt suggests that these cocci, when no wound exists, effect an entrance through the nose and the ethmoid foramina. In fractures at the base the organisms enter by way of the pharynx and the Eustachian tube, or the ear. The *symptoms* of acute leptomeningitis are violent headache persisting during delirium, rigidity of the neck, cerebral vomiting, a slow pulse, elevated temperature, contraction of the pupils, hyperæsthesia of the skin and muscles, and delirium passing into stupor and coma. Choked disk, strabismus, and nystagmus are not unusual. Convulsions or paralyses may occur. Death is the rule within one week. The *treatment* is purgation with calomel; bleeding behind the mastoid processes; cold to the head; warm baths with cold affusions to the head; iodide of potassium, bromide of potassium, or morphia for vomiting and headache. Some surgeons trephine.

Tuberculous Meningitis (Acute Hydrocephalus; Water on the Brain).—In a child affected with meningitis there is often a record of a fall. Prodromal symptoms are common (restlessness, irritability, anorexia, change of character). The

disease begins with a convulsion or with headache, fever, and vomiting (Osler), the child cries out from pain (the hydrocephalic cry), and the bowels are constipated. The pulse is rapid, but becomes slow and irregular. The pupils are contracted, there is muscular twitching, and the sleep is impaired. The temperature is about 103°. In the second period of the disease the vomiting ceases, constipation becomes more marked, the belly retracts, headache is not so marked, and the patient lies in a soporose condition with episodes of delirium. In this stage the pupils dilate and are often unequal, the head is retracted, convulsions occur or limited rigidity is noted, the respiration is sighing, and if a finger-nail is drawn along the skin, a red line develops (the *tâche cérébrale*, due to vaso-motor paresis). Squint and consequent double vision are usual. In the last stage coma becomes absolute and general convulsions or limited spasms are apt to occur. Optic neuritis exists, and the child passes to death along a road identical with that of typhoid collapse. In children the base is usually involved, and the disease is apt to last from two to four weeks; in adults the convexity of the brain is usually involved, and death is apt to occur in a few days. The *treatment* is like that for traumatic meningitis.

Acute Traumatic Leptomeningitis (Acute Encephalitis).—A day or so after the injury there appear severe general headache, photophobia, fever (102°–104°), a flushing of the face, intolerance of sound, contracted pupils, a full and bounding pulse (Keen), constipation, insomnia, and restlessness. A chill or chills may occur. Delirium soon sets in, linked with muscular twitching and strabismus, and followed by stupor, coma, rigidity, paralysis of sphincters, and a typhoid condition. Choked disk is sometimes found, though not often. In this condition all the membranes and the brain-substance suffer. Acute encephalitis should not be confused with uræmia.

Treatment.—Before coma arises, give from five to ten drops of Lugol's solution three times a day (Bartholow); during the stage of excitement give aconite and opium (Bartholow), and restrain convulsions with bromide of potassium. Mercury does no good. In acute traumatic encephalitis interrogate every organ. If a wound exists, asepticize it. Give a calomel purge and keep the bowels loose; shave the head; place the patient with the head raised in a cool, quiet, and darkened room; use the catheter whenever necessary; apply cold to the head by means of tubes or the ice-cap; in vigorous subjects employ venesection; leeches or wet cups over the mastoid and nape of the neck may be preferred to phlebotomy. Two drops of tincture of aconite and 5 drops of deodorized tincture of opium should be given every two or three hours during the stage of excitement (Bartholow), and ♏j of tincture of gelsemium may be given with each dose. Large doses of bromide are given to restrain convulsions and to secure sleep. Among the hypnotics that may be used are the hydrobromate of hyoscine, chloral, and paraldehyde. During the stage of excitement apply mustard plasters to the forehead and neck for a short period several times a day. When pressure-symptoms become evident, blister the nape of the neck, the vertex, or the mastoid region. If great depression comes on, give aromatic spirits of ammonia, or even wine (champagne or sherry). The diet is to consist of milk. If, during coma, constipation exists, give croton oil and glycerin. Never give much opium, as it constipates and adds to the congestion. It does no good to touch the gums with mercury: ptyalism will not check the inflammation, and will enhance the danger (Bartholow). If localizing symptoms of suppuration arise, at once trephine and drain. Many surgeons are approaching the belief that in this most fatal disease trephining should be performed to let out the

products of inflammation, thus relieving tension, even when pus has not formed and when distinct localizing symptoms do not exist. Should the patient recover, physical and mental exertion are forbidden for a long time, and he is guarded from excitement, worry, irritation, constipation, indigestion, and insomnia.

Chronic Leptomeningitis (or Encephalitis).—The *causes* of chronic leptomeningitis are the same as those of the acute form. If traumatism is the cause, the inflammation arises at a later period than it would in acute encephalitis. The *symptoms* of concussion follow a head-injury. Days, or even weeks, after the accident, a series of symptoms occur, namely: localized pain at the seat of injury, often accentuated by tapping; listlessness; irritability; apathy regarding business affairs and home obligations, or profound depression and hypochondria with inability to attend to business. Choked disk exists. Soon acute encephalitis arises, with or without a chill. The *treatment* of this disease is the same as that for acute encephalitis. Always operate if localizing symptoms are found. Intense local pain justifies trephining.

Abscess of the brain is a localized collection of pus. The *causes* are suppurative otitis media (in half of all the cases), fracture of the skull, concussion of the brain, and general septic diseases. A tubercular mass may caseate (tubercular abscess). The abscess may be between the dura and skull (extradural), between the dura and brain (subdural), or in the brain-substance (cerebral or cerebellar). A traumatic abscess is generally beneath the injured area, but it may be on the opposite side.

Symptoms of Abscess of the Cerebral Substance.—The symptoms due to pus-formation are as follows: There may be an initial rise of temperature, but (except in extradural abscess) the temperature becomes normal or

subnormal. Toward the end of the case the temperature may rise and the fever is linked with delirium. The local temperature over the abscess may be elevated. A chill may or may not occur. Anorexia and vomiting are present. Urinary chlorides are diminished and the phosphates are increased (Somerville). Symptoms due to pressure are —headache (which at first is general, then local, and grows worse later in the case, when fever arises and exists even in delirium: this fact distinguishes it from the headache of fever, which ceases in delirium); pulse is very slow; respiration tends to the Cheyne-Stokes type; stupor passes into coma; paralysis of the sphincters takes place; convulsions are common; sensation is rarely impaired; and paralysis of the basal nerves may occur (third and sixth especially). The pupil on the same side as the abscess is dilated and fixed. Choked disk is not invariably found; if it is unilateral, it is on the same side as the abscess; if it is bilateral, it is more marked on the same side as the abscess. In cerebellar abscess there are vertigo, vomiting, occipital headache, rigidity of the post-cervical muscles, and inco-ordination. Choked disk is often absent. Localizing symptoms depend upon the centre which is irritated or destroyed.

Meningitis arises soon after an accident; an *abscess*, more than a week, often many weeks, after an accident. Meningitis presents high temperature and the general symptoms before outlined. *Mastoid disease* may occasion cerebral symptoms without abscess, or it may cause abscess. In *sinus thrombosis* there is septic temperature, the veins of the face and neck are enlarged, and a clot can usually be felt in the jugular. A *tumor* grows slowly, usually presents almost from the start distant localizing symptoms, and double choked disk is frequently present. In tumor the temperature is apt to be normal.

Treatment.—If localizing symptoms exist, trephine the skull at once, and, if no pus is found between the bone and dura, open the membrane. When the dura is opened, if the abscess is subdural, pus will be evacuated; if the abscess is in the brain-substance, the brain will bulge very much and will not be seen to pulsate. A grooved director is plunged into the brain, in the direction of the abscess, for two or two and a half inches (Keen). If pus is not found, withdraw the director and introduce it at another point. When pus is found, incise the brain with a knife, enlarge the opening by expanding the blades of a pair of forceps, scrape away the granulation tissue lining the abscess-cavity, irrigate with boiled water, and introduce a rubber drainage-tube; stitch the dura, bring the tube out through a button-hole in the scalp, and after the first two days pull the tube out a little every day and cut off a piece. If the first trephining does not find pus, trephine again at another point. In cerebellar abscess, make a flap with the base up, and trephine or gouge away the bone just below a line drawn from the inion to the external auditory meatus (to avoid the lateral sinus). Puncture the brain as for cerebral abscess.

Brain Disease from Suppurative Ear Disease.—Chronic disease of the middle ear is apt to destroy the bone between the tympanum and the middle fossa of the skull, and thus produce meningitis, thrombosis of the petrosal or lateral sinuses, abscess of the temporo-sphenoidal lobe or of the cerebellum, or extradural abscess. This teaches the surgeon that chronic ear disease should never be neglected, but should receive the closest attention of the specialist if possible. In ordinary cases cleanliness and antisepsis are sufficient, the ear being syringed every day with a warm 2 per cent. solution of common salt. If only a small drum-perforation exists, 10 drops of pure alcohol or of corrosive-sublimate solution (1 : 5000) are dropped into the ear, but

if a large drum-perforation exists, boric acid and iodoform (7 to 1) are insufflated. Never inject alum. A strong silver solution is not safe; if it is used, wash the ear out afterward with warm salt water. If granulations or polypi exist, they must be removed (Burnett). Some cases require the removal of the drum-membrane and the ossicles of the ear. If headache, vomiting, and mastoid tenderness exist, open the mastoid at once (see *Operations*) to prevent abscess of the brain.

Cerebral abscess from ear disease is almost always in the temporo-sphenoidal lobe. The *symptoms* are—sudden disappearance of the ear-discharge; a transient rise of temperature followed by a subnormal temperature; vomiting; mastoid, frontal, and temporal pain; the mind is dull, and stupor arises which passes into coma; the bowels are constipated; choked disk may be present; and convulsions or spasms or paralyses may exist. Trephine and clean out the mastoid antrum, and asepticize (see *Operations upon the Skull and Brain*). Trephine at Barker's point, one and one-fourth inches behind, and the same distance above, the middle of the external auditory meatus. If pus is not found, open the cerebellum.

Extradural Abscess.—The eye symptoms and pain are the same in this as in cerebral or subdural abscess, but the temperature is different, rising to 103° or 104°. There is often considerable tenderness above and behind the mastoid. Trephine and clean out the mastoid; follow up a sinus to the abscess, rongeur away the bone, avoiding the lateral sinus, curette, irrigate, and drain.

Infective Sinus Thrombosis (a form of Pyæmia).—The *symptoms* of this disease present a history of chronic ear disease; general headache and pain over the sinus arise; violent rigors occur; and the temperature rises and fluctuates greatly. Tenderness and marked œdema are detected over the mastoid. A clot may be felt in the neck, in the

internal jugular vein. The veins of the face swell. Choked disk usually exists. The mind is generally clear, at least for a time.

Treatment.—Infective sinus thrombosis is treated as follows: Open and clean out the mastoid, and expose the sinus; irrigate; open the sinus, which, if full of clot, will not bleed; introduce a small spoon in the sinus, carry it toward the torcular Herophili, and scrape away the clot until blood flows. When bleeding begins, arrest it by packing the side of the sinus toward the occiput. Incise the neck, expose the internal jugular vein, ligate the vein *below* the clot, divide the vein above the ligature, and wash out the clot by running a stream of corrosive sublimate in at the lateral sinus and out at the cut jugular. Suture the neck-wound, drain the mastoid, and apply sutures in the soft parts.

Intracranial tumors may be true neoplasms, may be of parasitic origin, may result from injury, or may be tubercular or syphilitic. Among these tumors are papillomata, gliomata, sarcomata, fibromata, psammomata, myxomata, osteomata, etc. (see *Tumors*). Cysts sometimes occur. The *symptoms* are diffuse and local, and are similar in many particulars to the symptoms of some other lesions. Among the symptoms are headache, pain on percussion, vertigo, vomiting, epileptic convulsions, double choked disk, partial or complete blindness, paralyses of eye-muscles, paralysis of face or of limb, anæsthesia and aphasia, word-deafness, word-blindness, agraphia, inco-ordination, and mental disturbances. The situation of a tumor is fixed from localizing symptoms, their mode of onset and manner of combination. The nature of the tumor, its size, its depth, and whether it is single or other tumors exist, is, if possible, determined.

Treatment.—If the tumor is located in an accessible region and operation is indicated, trephine the skull, enlarge the opening with the rongeur, open the dura, and turn out the

tumor by means of the finger, or, if this is impossible, by using an Allis dissector, a knife, the scissors, or a sharp spoon. If the tumor is beneath the cortex, incise the brain with a knife. Arrest bleeding, stitch the dura, drain, and close the wound.

Operative Treatment of Epilepsy.—When epilepsy has followed traumatism and a scar exists upon the scalp, excise the scar, especially if it is tender or is the seat of an aura. If, on lifting the scalp, a depression of bone or a disease of the bone is manifest, trephine for exploration, even over a silent area. Remember that epilepsy, as shown by Sachs, may follow a long-forgotten injury. Where the injury is over a known centre, trephine. This operation is especially indicated when the convulsions begin in the muscles of this centre, in which case remove the centre after trephining. Remove all sources of peripheral irritation (Briggs reported a case of epilepsy in which there was distinct skull-depression and necrosis of the tibia, but the cure of the necrosis stopped the fits). Trephining in epilepsy may disclose a cyst, a dural scar, a brain-scar, a depressed portion of bone, or eburnation of bone from osteitis (Keen). In exploratory operations for epilepsy, always open the dura. If epilepsy arises notwithstanding a primary trephining, open the flap, round the bony edges with a rongeur, and cut out the scar.[1]

These operations often seem to cure, but sometimes so does any operation. Dr. White records[2] ninety trephinings in which, though nothing was found, great relief followed, and two cases were apparently cured; he mentions benefit or apparent cure following tracheotomy, ligation of the carotid, incision of the scalp, etc. The fact seems to be that any operation, by means of nervous shock, may interrupt

[1] The author, in Hare's *System of Practical Therapeutics.*

[2] "The Supposed Curative Effects of Operations *per se*," *Annals of Surgery*, August and September, 1891.

the epileptic habit; but in ordinary operations the fits tend to recur, and soon reach their old standard of frequency. In the special brain-operations with excision of obvious lesions or discharging centres, the fits often recur, but they will rarely reach the old standard of frequency, and will be more amenable to medical treatment. In non-traumatic epilepsy the fits are to be studied by a competent observer (Keen), and, if focal epilepsy or Jacksonian epilepsy exists, trephining is to be performed over the diseased centre and the explosive focus is to be located by an electric current and removed. In favor of this procedure is the high authority of Keen, Horsley, and Macewen. This operation causes paralysis, but the paralysis is rarely permanent except, perhaps, to the finer movements.

In non-traumatic chronic epilepsy without localizing symptoms trephining is not justifiable unless persistent headache calls for it as a means of relief from intracranial pressure. After trephining for epilepsy five years should elapse without a convulsion before cure is reasonably assured, and if convulsions arise, they must at once be met by medical treatment. A man having once had a convulsion may at any time have more; hence he should always be watched. It is not unusual for a few convulsions to occur soon after an operation, and then to cease. These early fits result from habit. Among the operative procedures suggested for the treatment of epilepsy may be mentioned circumcision, clitoridectomy, ocular tenotomy, ligation of the vertebral arteries, removal of the cervical ganglia of the sympathetic (Alexander), and the actual cautery to the head (Féré).

Operations on the Skull and Brain.—Trephining (for a fractured skull).—Shave the scalp, wash it with ethereal soap, then with ether, scrub with a brush wet with corrosive-sublimate solution (1 : 1000), and wrap up the scalp in wet corrosive-sublimate gauze (1 : 2000). The instruments

required are a scalpel, an Allis dissector, hæmostatic, dissecting, and toothed forceps, trephines of several sizes, a periosteum-elevator, a Hey saw, rongeur forceps, a bone-elevator, a dural separator, a tenaculum, small curved Hagedorn needles, and a needle-holder. Provide a sand pillow. The patient lies upon his back, the shoulders are a little raised, the sand pillow is placed under the neck, and his head is turned away from the side to be operated upon. The position of the surgeon is such that the patient's head is a little to his left. A large semilunar incision is made with the base down, which incision goes through the periosteum, and the flap is lifted. The bleeding vessels of the flap are caught with forceps. The pin of the trephine is projected beyond the crown and is set upon sound bone, the crown overhanging the line or edge of the fracture. A gutter is cut in the bone, the pin is withdrawn, and the trephining is completed. In going through the diploë bleeding is copious and the inner table feels very dense. Stop from time to time, clean out the gutter with the dissector, and try the bone with an elevator to see if it is loose. When the fragment is loose enough, pry it out and hand it to an assistant, who places it at once in a bowl of solution of corrosive sublimate (1 : 2000) kept warm by standing in a basin of water at 105°, or who puts it in warm carbolized towels or in warm normal salt-solution. The edges of the opening are rounded with a rongeur and the bone is elevated. Sometimes it may be necessary to remove splinters and fragments of bone. The dura is examined to see if injury exists, hemorrhage is arrested, the wound is cleansed, the button of bone is reintroduced, or some chips are cut from it and scattered upon the dura. The scalp is sutured and horse-hair drainage is employed for a day or two. Sterilized gauze dressings are put on, a rubber dam is laid over them, and a gauze bandage wet with bichloride-of-mercury solution is applied.

Technique of Brain-operations (after Horsley and Keen).—Always shave the scalp, and always antisepticize it. In localizations, mark out the fissure upon the scalp with an aniline pencil or with iodine. Have the patient semi-recumbent. Mark three points upon the bone with the centre-pin of the trephine before incising the scalp (both ends of the Rolandic fissure and the point at which the trephine will be applied). Make a semilunar flap three inches in diameter, with the base below. Control bleeding in the flap by forceps pressure. The one and a half inch trephine is used, but, if a smaller trephine is employed, the opening must be enlarged with a rongeur. Before enlarging the opening, separate the dura from the bone by a dural separator. As a rule, open the dura and examine the brain. The dura is lifted by rat-toothed forceps and is opened with scissors along a line a quarter of an inch from the bone-edge. Hemorrhage is arrested by pressure and hot water or by passing a curved needle threaded with catgut around any bleeding vessel. In some cases packing must be left in or forceps must be kept on. In packing, never use more than one piece of gauze, so as to avoid leaving in a forgotten piece. Upon opening the dura, cerebro-spinal fluid flows out, the stream being increased with each expiration. Absence of pulsation of the brain points to tumor, and a livid color indicates subcortical growth. An old laceration is brownish. If the brain bulges through the opening, it means increased pressure (tumor, abscess, effusion into the ventricles, etc.). After opening the dura, employ no antiseptics except boiled water, especially when the surgeon intends using electricity to locate a centre. Remove any abnormal brain-tissue which is found. In electrifying the brain, faradism is employed of a strength about sufficient to move the thenar muscles when applied to them. After an aseptic cerebral operation, as a rule, do not drain. In many cases replace the bone, but not when the bone is

diseased, is infected, or is very compact, or if it is desired to alter pressure. The dura is sutured by a continuous catgut suture (Fig. 131); the scalp is sutured by interrupted silk-worm gut (Fig. 132).

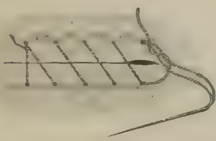


FIG. 131.—Continuous Suture.

FIG. 132.—Interrupted Suture.

Operation for Mastoid Suppuration.—The instruments required in this operation are a scalpel, a gouge, a chisel, a mallet, curettes, a probe, a dissector, dissecting and hæmostatic forceps, and needles. Provide a sand-bag to place under the neck. An incision is made one-quarter of an inch posterior to the auricle and down to the bone. The bone is bared and examined especially at a point in the line of the incision which is on a level with the roof of the meatus. The bone will usually be found softened. Gouge it away and thus open the mastoid antrum. This bone-opening is within the limits of Macewen's suprameatal triangle, a space bounded by the posterior root of the zygoma, the posterior bony wall of the meatus. and a line joining the two. If, in the adult, pus is not found, gouge downward and backward, but with great care, so as to avoid the lateral sinus. After evacuating the pus, scrape out the cavities with the curette, enlarge the opening between the mastoid and the middle ear with the gouge, turn the head toward the side operated upon, and irrigate the mastoid with corrosive-sublimate solution (1 : 2000); dust in iodoform, pack with iodoform gauze for a few days, and then introduce a silver drainage-tube. Treat the causative ear disease.

If mastoid suppuration has established *abscess in the*

temporo-sphenoidal lobe, trephine one and a quarter inches behind and one and a quarter inches above the middle of the external meatus (Barker's point), and search for pus as directed on p. 559. If *abscess of the cerebellum* exists, trephine below the line of the lateral sinus—that is, below a line running from the inion to a point on a horizontal line from the roof of the meatus, one inch posterior to the middle of the meatus. If *infective sinus thrombosis* exists, break into the lateral sinus through the mastoid opening and proceed as directed on p. 560.

XXIII. SURGERY OF THE SPINE.

Congenital Deformities.—*Spina bifida*, or *hydrorrhachitis*, is a congenital cystic tumor due to vertebral deficiency, permitting protrusion of the contents of the spinal canal in the median line. The laminæ or spines of one vertebra or of several vertebræ may be deficient, most frequently in the lumbo-sacral region. *Meningocele* is a protrusion of dura mater and arachnoid, the sac containing cerebro-spinal fluid, but no nerves and no cord-substance. *Meningo-myelocele* (the commonest form) is a protrusion of dura mater and arachnoid, the sac containing cerebro-spinal fluid, nerves, and cord-substance. The cord may spread out upon the sac-wall or it may pass through the sac and re-enter the canal. *Syringo-myelocele* is great distention of the central canal, the sac-wall being formed of the thinned cord. A hydrorrhachis varies in size from that of a walnut to that of a child's head; it grows rapidly during the early weeks of life; it is usually sessile, but may present where it joins the body a definite constriction, or even a pedicle; the base of the sac is covered with healthy skin, and the fundus is covered only by thin epidermis or by the spinal membranes themselves. Pressure upon the tumor is found to diminish

its size and to increase the tension of the anterior fontanelle, and possibly to cause convulsions or stupor. The cyst is translucent, and the margins of the bony aperture are distinct. Crying, coughing, or pressure upon the anterior fontanelle makes the tumor more tense. Spina bifida is apt to be associated with club-foot, with hydrocephalus, and with rectal or vesical paralysis. Spina bifida usually causes death. A few meningoceles and a very few meningo myeloceles undergo spontaneous cure by the shrinking of the sac. Syringo-myelocele is invariably fatal. The cause of death may be rupture of the sac or marasmus.

Treatment.—Very small protrusions which grow slowly and are covered with sound skin may be treated by the use of a compress and bandage, by an elastic bandage, or by applications of contractile collodion. Some surgeons tap and drain the sac. Injection is used by many. The sac being cleaned, the child is placed on its side and a little chloroform is given. A fine trocar is plunged obliquely in at the side through sound skin, little or no fluid being drawn off, and ʒj of Morton's fluid is injected (iodine, gr. x; iodide of potassium, gr. xxx; glycerin, ℥j). The trocar is withdrawn and the puncture is sealed with a bit of gauze and iodoform collodion. The child is put to bed. If the injection proves successful, the sac shrinks; if the injection fails, it may be repeated at intervals of from seven to ten days (Jacobson, White). Many surgeons prefer excision of the sac. Bayer treats it as he would a hernia.

Tumors of the Spine.—Among congenital tumors are lipomata and cysts (dermoid, congenital, sacral, and fœtal). Tubercle, gumma, psammoma, and fibroma may arise from the cord or its membranes. Glioma is the most usual growth. Primary sarcoma is rare. Angeioma may occur. Carcinoma is never primary. A tumor rarely produces obvious symptoms until it is as large as a hazel-nut.

Symptoms and Treatment.—Pain, stiffness of the back, areas of anæsthesia, and progressively advancing motor paralysis are symptoms of spinal tumors. A tumor may produce the symptoms of compression-myelitis, locomotor ataxia, or myelitis. In glioma there are apt to be loss of ability to recognize variations of temperature (or even to distinguish between heat and cold), loss of the sense of pain, and paresis and atrophy of muscles. Contractures or paraplegia may arise. The location of the tumor can be inferred by a study of the territory of paralysis and the zone of sensory disturbance. The tumor is always somewhat above the upper limit of anæsthesia. In many cases the diagnosis is impossible. Gradually increasing painful paraplegia, with pain in the back or with sensory paralysis after a time appearing and ascending from the feet toward the trunk, points to tumor as a cause. The reflexes are at first increased, but are finally lost from below upward. Spasms may develop, and spinal curvature may arise. Growths outside the membranes produce more pain and spasm; growths within the membranes produce more motor paralysis and anæsthesia. If syphilis is suspected, give the patient a heroic course of iodide of potassium. In a focal lesion not due to dissemination of a known malignant growth, perform the operation of laminectomy to permit of exploration and possibly of removal.

Spinal Curvatures.—There are four chief forms of spinal curvature: (1) lateral curvature (the scoliosis of the older surgeons); (2) posterior curvature (the excurvation, gibbosity, or kyphosis of the older surgeons); (3) anterior curvature (the lordosis of the older surgeons); and (4) angular curvature (from spinal caries). The normal spine has four curves: the *cervical* curve, the convexity of which is forward; the *dorsal* curve, the concavity of which is forward; the *lumbar* curve, which is convex anteriorly; and

the *pelvic* curve, which is concave anteriorly. The dorsal and the pelvic curves, which are primary, are due to the formation of the cavities of the chest and pelvis, and depend upon the shape of the bones (Treves). The cervical and lumbar curves, which are compensatory, depend upon the shape of the intervertebral disks, and only appear after birth when the erect position is assumed.

Lateral curvature (scoliosis) is a lateral deviation of the spinal column, often accompanied with rotation of the vertebræ and associated with increase or with diminution of the normal curves. Lateral curvature is predisposed to by weak muscles and ligaments, by the habitual assumption of strained and unnatural attitudes, by unequal length of the legs, and by paralysis of one leg. This distortion, which is commonest in girls, is apt to arise at the age of puberty (it is usually corrected in boys by outdoor exercise). The bones are soft and the muscles are weak, and this condition is often hereditary. Rickets is very commonly associated with lateral curvature. Any condition of ill-health weakens the muscles; hence lateral curvature may arise after an acute sickness or in a person who outgrows his strength. An empyema with adhesions, by pulling on the chest-wall, may produce a curvature the concavity of which is toward the diseased side.

The weak muscles cease to sustain the spinal column, and the ligaments stretch, relax, or lengthen. The commonest curve is toward the right in the dorsal region (because most people use the right hand more than the left). As soon as a dorsal curve to the right arises, a compensatory lumbar curve (Fig. 133) takes place to the left, thus enabling the patient still to sit or to stand erect. In almost all cases the vertebræ soon rotate, the bodies turning to the convexity and the spines turning to the concavity of the curve; hence the transverse processes toward the convexity project. The

ribs follow the spinal rotation; the shoulder is elevated on the side of the convexity, and the hip on the same side is raised (Bowlby). The intervertebral disks are apt to flatten out on the concavity of the curve. In very rare instances lateral curvature results from caries of a half of one or of several vertebræ. In a spinal tumor lateral curvature may occur, the concavity of the bend being on the side of the growth.

Symptoms.—An ordinary case of spinal curvature from weak muscles comes on gradually with stooping, and after a time with pain in the dorsal and lumbar regions and weakness in the back. The pain is made more severe by walking or by sitting long in one attitude. Anæmia is manifest, and walking is awkward and ungraceful. When the shoes and clothing are removed, and the child stands with its back toward the surgeon and the feet symmetrically together, the lower angle of the right scapula (in a dorsal curvature to the right) is unduly prominent and is elevated above the left; the normal prominence of the left iliac crest is lost; the right iliac crest is unduly distinct; on marking the spinous processes with an aniline pencil the curve becomes manifest; tenderness is often developed on pressing the spines; the normal dorsal antero-posterior curve is exaggerated; the abdomen is protuberant; the chest is flattened; the neck juts forward; and the breast on the same side as the concavity of the curve is more prominent and on a lower level than the other breast. Always observe if the anterior iliac spines are on a level or not, and always measure the length of the legs. The patient, with the knees extended, bends forward with the arms hanging loosely: the erector spinæ muscle between the iliac crest and the last rib is seen to be more prominent on the convexity of the lumbar curve than on its concavity (Bernard Roth), and

FIG. 133.—Lateral Dorsal Curvature to the Right, and Compensatory Lumbar Curve to the Left.

the angles of the ribs on the side of the convexity of the dorsal curve are on a higher level than are those on its concavity. Have the child assume what it supposes to be an erect attitude, and let the surgeon correct this into the best possible position (Roth), and see how long it can voluntarily be maintained. A large percentage of these patients labor under pes planus. When there is no osseous deformity (that is, when the surgeon can correct the deformity), and when the spinal muscles are not paralyzed, the prognosis is good for complete cure. Roth states that cases without osseous deformity can practically be cured in one month, but the treatment must be continued for one year to prevent relapse.[1] In cases of moderate osseous deformity the patient can be improved vastly by three months' daily treatment (Roth). Even in severe cases of bony deformity the pain may be relieved and the deformity be modified.

Treatment.—If one leg is too short, let the patient wear a thick-soled shoe. No treatment for weak muscles has ever been devised so utterly irrational and absurd as the prevention of all movement; and neglect of all treatment for lateral curvature does less harm than immobilizing the spinal muscles by braces and supports. The muscular nutrition in these cases is to be restored, as is muscular nutrition in any other region, by scientific gymnastics, electricity, the douche, salt baths, frictions, and massage. Roth's advice is to so re-educate the muscular sense that a patient can again know whether she is or is not standing straight; to maintain an improved position in sitting and standing; to use such clothing as will not interfere with the assumption of a normal attitude; to enforce systematic training of the muscles of the spine and thorax; and to give attention to the general health. In those rare lateral curvatures due to caries a supporting apparatus must of course be applied.

[1] Heath's *Dictionary of Practical Surgery.*

Antero-posterior curvature (not from spinal caries or from hip-joint disease) is an increase of the normal antero-posterior curves. Increase of the dorsal curve is posterior curvature, kyphosis, or excurvation (Fig. 134, A); increase of the lumbar curve is anterior curvature, lordosis, or saddle-back (Fig. 134, B). Both lordosis and kyphosis are apt to be present. Scoliosis has nearly always some antero-posterior curvature associated with it. Lordosis is apt to be compensatory, to prevent the centre of gravity going too far forward. Lordosis is found in pregnant women and in very fat men. In an old man kyphosis arises from flattening out of the vertebral disks from pressure. Rheumatic gout may cause it. Antero-posterior curvature is often due to paralysis of the erector spinæ mass (from infantile paralysis). Pseudo-hypertrophic paralysis causes lordosis.

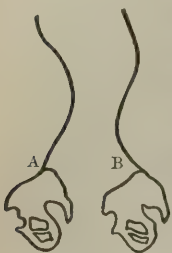


FIG. 134.—Kyphosis (A) and Lordosis (B).

Symptoms and Treatment.—The symptoms of antero-posterior curvature are as follows: The thorax is flattened or pigeon-breasted; the shoulder-blades are widely separated and the scapular angles project; the abdomen is protuberant; the patient complains of backache and soon tires. A recent kyphosis disappears when the patient lies upon his stomach. The fact that the erector spinæ muscles are soft, and the absence of pain on concussion transmitted from the heels, separate kyphosis from caries. Lordosis is unmistakable. When the spine is movable, employ the same plan of *treatment* as that in lateral curvature, suiting the gymnastics to the deformity (Roth). In painful kyphosis with partial ankylosis, endeavor to make the ankylosis complete to prevent pain, obtaining this result by applying a plaster jacket which laces up and letting the patient wear it for several years.

Angular curvature (spinal caries, Pott's disease), which is strumous caries of the vertebral bodies, occurs particularly in children who are scrofulous, but it may arise at any age. The dorso-lumbar region is most prone to suffer. The *causes* are struma and syphilis. Blows or strains are often exciting causes. It may develop after an exanthematous fever.

The cancellous tissue of the anterior portion of a vertebral body becomes primarily carious, or the inflammation may begin in an intervertebral disk. (The changes of strumous osteitis have previously been set forth.) The body of the vertebræ and the adjacent vertebral disks are destroyed, and the process extends to adjacent vertebræ. The weight which rests upon the spinal column crumbles down softened bone, compresses the diseased vertebræ and disks, and produces angular deformity (the anterior part of the spine formed by the vertebral bodies is shortened, the posterior part is not, and hence the spines project). In some cases the disease is spontaneously arrested by organization of inflammatory products, and ankylosis (fibrous or bony) in deformity is Nature's cure. In most cases, however, the disease spreads and caseous pus is formed, which, according to the route it takes, causes lumbar abscess, dorsal abscess, psoas abscess, or post-pharyngeal abscess (pp. 98, 99). In some cases the spinal cord is compressed, but in most cases it is not, and even when it is compressed, paraplegia is rare and is usually temporary. Pachymeningitis is apt to arise. Caries of the cervical region constitutes a more dangerous disease than caries of either the dorsal or the lumbar regions (dangerous pressure occurs more easily). Death may be caused by exhaustion, sepsis, hemorrhage, amyloid disease, pneumonia, peritonitis, pleuritis, tubercular dissemination, and pressure upon the cord.

Symptoms.—The first symptom of angular curvature is pain in the back, which is increased by motion, by pressure,

and by vertebral jars. Neuralgic pains pass into distant parts (sciatica, intercostal neuralgia) and are often linked with muscular spasm. In cervical caries there is often wry-neck. Cramp in the legs occurs in dorsal or lumbar caries. The patient, if a child, grows tired easily, shows alteration of disposition, becomes moody and irritable, complains of vague pains in many places, constantly leans, rests, or lies down, and walks with the back rigid, which produces a peculiar gait. If asked to pick up something from the ground, the child will not bend the back, but bends the knees or gets upon the knees instead. A painful spot is found by pressing upon the spines, and the same spot is painful on pressing the head downward or upon jarring the entire spine. Spasm of the erector spinæ is detected (C. Hilton, Golding-Bird). The pain is relieved by lifting the shoulders. When angular deformity begins, it is easily recognized. Paralysis may exist, and it is due to pachymeningitis more often than to pressure from bone. Cervical caries causes dyspnœa and torticollis, the head requiring support with the hand. Dysphagia indicates abscess. In adults the first signs of Pott's disease to attract attention are backache, neuralgia, girdle-pain, cramp, or even paralysis.

Treatment of Caries of the Spine.—When recent caries of the spine is active and affects a child, when it is accompanied with pain and fever, and when paralysis threatens, insist upon perfect rest. Place the child supine on a hard mattress, and, if possible, take it, while still in bed, out of doors daily. Leeches, blisters, or the hot iron over the area of pain may do good. When the disease is not active or when it arises in an adult, apply Sayre's plaster-of-Plaster jacket (Fig. 135). When "all subjective signs cease" (Golding-Bird), substitute for Sayre's jacket a felt jacket which laces. In diseases at or near the vertebro-occipital articulation, as long as dyspnœa persists, keep the patient supine with a

small hard pillow under the nape of the neck (Hilton) and a sand-bag on each side of the head and neck. After several months mechanical support can be given by Furneaux Jordan's apparatus. In disease of the cervical region below the axis, or in cervico-dorsal disease, use Sayre's jury-mast

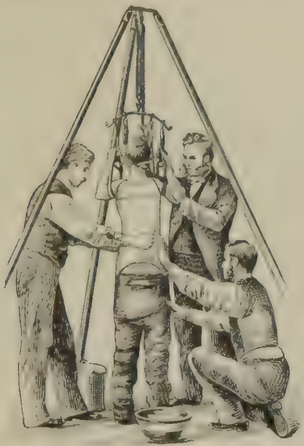


FIG. 135.—Plaster-of-Paris Jacket (Sayre).

FIG. 136.—Plaster-of-Paris Jacket and Jury-mast Applied (Sayre).

(Fig. 136). Treat abscesses as indicated on pages 98 and 99. Treves's operation for caries will be found upon page 479. Paralysis, if due to cord-inflammation, is treated by iodide of potassium, absolute rest, and counter-irritation. During the course of caries of the spine, give oleum morrhuæ, tonics, and nutritious food, and try to get the patient out often into the fresh air. Sea-air is very beneficial. When all active disease ceases, and angular curvature only remains, use an apparatus to combine extension with mechanical support, the plaster jacket being generally employed.

Injuries of spinal ligaments and muscles, which may complicate more serious injuries or may exist alone, are caused by wrenches, twists, and violent muscular efforts (as in lifting). Railway accidents may be responsible for these

sprains and strains. The *symptoms* soon after the accident are—considerable shock, as a rule, even hysterical excitement; pain, which is felt in the back and often shoots into the extremities, and which is much increased by moving the muscles; tenderness; muscular rigidity, which in one-sided lesions is unilateral (unilateral rigidity cannot be simulated); and often, but not always, swelling and discoloration. The vertebral spines are regular and are not mobile. There is no distant paralysis or hyperæsthesia unless the cord is damaged (though in some rare cases the bladder and the rectum are paralyzed when no cord-lesion can be detected), and hyperæsthesia may exist over the spines. The *treatment* of recent injuries comprises rest; the ice-bag and leeching over the painful area; in a day or two hot fomentations, tincture of iodine, and inunctions of ichthyol and lanolin; and, later, massage, the douche, and frictions with a stimulating ointment. Phenacetin relieves pain, though in some cases opium is necessary. The injury is called "railway spine" when it is caused by a railway accident.

After the *immediate* effects of the accident subside, traumatic neurasthenia is apt to arise. In this condition the patient grows tired easily and complains of pains and aches in the back and loins, interfering with or preventing work; paræsthesia and numbness exist in the extremities; in many cases sexual intercourse is impossible because of premature ejaculation or of incapacity for erection; there are dyspepsia, eye-strain, insomnia, loss of memory, rapid and irregular pulse, cardiac palpitation, and mental depression or confusion. The reflexes are usually exaggerated, but they can be exhausted more easily than can the exaggerated reflexes of organic cord disease (because of irritable weakness). Some rigidity and tenderness exist in the back, and the skin over this region is often hyperæsthetic. Attacks of retention of urine may occur. Hypochondria is not unusual.

Treatment of Traumatic Neurasthenia.—Rest, tonics, massage, douches, and frictions to the back. Secure sleep, and endeavor to bring about a gain in weight. If sexual incapacity or seminal emissions worry the patient, dilate the urethra with steel bougies.

Traumatic hysteria develops only in those predisposed by a neuropathic hereditary tendency; traumatic neurasthenia may arise in anybody. In the first disease the accident is only the *exciting* cause; in the second disorder it is *the* cause. Many cases of so-called "railway spine" are really examples of traumatic hysteria. Traumatic hysteria and neurasthenia may be associated. Neurasthenia is a condition of exhaustion associated with a number of chronic disorders; it forms a foundation on which hysteria loves to build its structure of morbid impressionability, hyperæsthetic centres, lowered self-control, and sensitive peripheral nervous system. The accident plays a double part in producing traumatic hysteria: first, by its effect on the mind (psychical traumatism); second, by its effect on the body, which anchors the attention at one point, and this area of pain or stiffness often serves as an auto-suggestion which undergoes morbid magnification when viewed through the distorting medium of hysteria. Erichsen used to teach that the varied symptoms of what he named "railway spine" arose from inflammation of the cord and its membranes. A blow given to a hysterical person causes a feeling of numbness, and this negative sensation from local shock may establish the idea of paralysis, or the traumatism, acting as a suggestion, inhibits motor representations and destroys the normal ideas of motion and feeling (Charcot and Pitre). Terror always causes a feeling of loss of power in the legs, and the terror of the accident may thus develop the idea of paraplegia. The site of a traumatism may localize symptoms; for instance, a blow upon the eye may

cause amaurosis or blepharospasm. It is important to remember Charcot's saying that a hysteria, long latent and unrecognized, may be awakened into obvious activity by a blow or an accident. Pitre shows the same to be true of epilepsy. A not unusual lesion is hysterical traumatic monoplegia, not coming on at once after the accident, but usually some days afterward, and presenting flaccid muscles, the electrical reactions and reflexes remaining normal, but the muscular sense being lost (Pitre). The muscles usually waste. The skin of the paralyzed limb is anæsthetic or analgesic. There may be anæsthesia limited to a limb, hemianæsthesia, or general anæsthesia.[1] Hysterical paralysis is usually associated with the permanent stigmata of hysteria—concentric contraction of the visual field, pharyngeal anæsthesia, convulsive seizures, and hysterogenic zones (Clarke and Pitre). The permanent stigmata may be latent. Hysterical phenomena lack regularity of evolution, and they can be produced, altered, or abolished by mental influences or by physical forces which produce no effect on organic disease. In most hysterical conditions the general health is not profoundly impaired.[2]

Treatment.—By moral means chiefly. Gain the confidence of the patient. In many cases separation from family and friends is necessary and isolation is desirable. The Weir Mitchell rest-cure is the best plan of treatment, and all its details should be carried out faithfully.

Malingering.—Persons injured in accidents are often apt to pretend to maladies which do not exist. Some get well upon the rendering of a favorable verdict by a jury. In any case always examine carefully, so as to be able to exclude malingering. Note the patient's behavior and motions when his attention is diverted from his disease. *Meningo-myelitis* can be excluded if there be no spasm nor

[1] J. Michell Clarke in *Brain*. [2] Read the works of Thorburn and Pitre.

paralysis, hyperæsthesia, paræsthesia, or anæsthesia at a distance (A. Pearce Gould). If pain has lasted for months, if pressure downward upon the head or shoulders does not increase pain, if the vertebræ are movable and there is no angular displacement, exclude *caries*. Gould states that when there are wasted muscles, when moderate spine-movement is painless, but effort in bringing the body erect causes pain in the erector spinæ region, the trouble is a sprain of the erector spinæ muscle. If the muscle is not wasted, and the pain is in bending forward rather than in straightening up, the vertebral ligaments are the seat of trouble. Unilateral spasm cannot be simulated. The administration of ether may dispose of a pretended paralysis.

Concussion of the Spinal Cord.—This term has no definite pathological meaning. It is probable that the condition is one of laceration. The *symptom* is shock, with intense pallor, nausea, often vomiting, and sometimes syncope. To this condition special symptoms may be linked—as temporary paralysis, a girdle-sensation, numbness and loss of power in the limbs, hiccough, torticollis, coarse tremors, pains in the back and limbs, areas of anæsthesia and analgesia—depending on the portion of cord lacerated.

Treatment.—The treatment in concussion of the spinal cord is the same as that for sprains. Traumatic neurasthenia and hysteria or organic cord disease may follow this injury.

Contusion of the spinal cord may arise from a sprain, but it is usually due to extreme flexion of the spine. It causes hemorrhage into the gray matter of the cord (hæmatomyelia). The *symptoms* are motor and sensory palsy and diminished reflexes. Some cases recover, but others end in myelitis.

Wounds of the spinal cord, which are rare, are usually fatal. Wounds above the origin of the phrenic nerves cause almost instant death. Gunshot wounds are the most usual

form, the cord being damaged by the bullet and by bone-fragments. A knife is sometimes thrust in between the occiput and atlas.

Compression of the spinal cord may be due to blood or to lymph. *Compression from blood* may be due to *extra-medullary* hemorrhage or to *intramedullary* hemorrhage. *Extramedullary* hemorrhage causes sudden pain in the back, the pain radiating from compressed nerve-roots; hyperæsthesia and paræsthesia in the area of the radiated pain; spasm of vertebral muscles supplied by the compressed nerves, sometimes of muscles whose nervous supply is below the lesion; tremors; convulsions; retention of urine; paralytic symptoms following the signs of irritation, but no absolute paralysis (Mills). A girdle-sensation is usual. *Intramedullary* hemorrhage causes pain, a girdle-sensation, abolition of reflexes, and paralysis. Spasms, rigidity, and paralysis come on early. Bed-sores, retention of urine, and incontinence of feces may occur.

Treatment.—If paralysis from spinal-cord bleeding extends rapidly, and life is endangered through the probable involvement of a vital centre, perform a laminectomy (White). In some cases with persistent paraplegia the operation should be undertaken. If operation is not undertaken, cause the patient to lie upon his side and give morphia hypodermatically. If hemorrhage continues in the cord and if the patient be plethoric, perform venesection. Some surgeons advise hypodermatic injections of ergotin. To promote absorption of the clot and exudate, give a combination of carbonate and acetate of ammonium, order pilocarpine, and employ spinal galvanism and the hot douche (Bartholow).

Fractures and dislocations of the spine are very rare. The spinal regions most liable to injury are the atlo-axial, the cervico-dorsal, and the dorso-lumbar (Treves). A vertebra may be fractured alone, but dislocation without fracture,

except in the upper cervical region, very rarely occurs. These two lesions, dislocation and fracture, are so often associated that the term *fracture-dislocation* is used by many surgeons to include them both. The *causes* of fracture and dislocation are direct force (rarely) and indirect violence (commonly). Fracture-dislocation from direct force may occur at any part of the column, and in this accident the posterior vertebral segments are driven together. The cord, as a rule, escapes. Direct force may damage the bones only. Fracture-dislocations from indirect force most commonly happen in the cervical and dorsal regions. In the cervical region reduction can usually be secured, but in the lumbar region reduction is impossible. In fractures from indirect force the cord generally suffers.

Symptoms.—In fracture-dislocations much displacement is rare, but some is almost always recognizable (irregularity of spines or angular deformity). In fractures there are pain (which is increased on motion), tenderness, ecchymosis, and motor and sensory paralysis. Priapism, cystitis, and retention of urine often occur. The extent of paralysis depends on the seat of the cord-injury. The prognosis depends on the amount of damage done to the cord. Fracture-dislocations in the cervical region produce obvious deformity, stiffness of the neck, and irregularity of the spines, and a displaced vertebra may occasionally be detected by a finger in the pharynx. Crepitus can rarely be detected unless a spinous process is fractured.

Treatment of Fracture-dislocations.—When dislocation obviously exists, attempt reduction by extension and rotation (White). This manœuvre is very dangerous in the cervical region, and, as deaths have happened, some eminent surgeons advise against reduction when the injury affects that region. In fracture-dislocation the traditional plan is to straighten the spine gently if possible and to put the patient

upon his back upon a water-bed or upon air-cushions. In fractures in the cervical region, support the head and neck with sand-bags. Empty the bladder four times every twenty-four hours with a soft catheter which is kept strictly aseptic. Take every precaution to prevent bed-sores. Some surgeons advocate reduction of the deformity by extension and counter-extension, and by the application of a firm-fitting but removable jacket with the suspension collar (as used in Pott's disease). The head of the bed is raised and the collar is fastened to it. Every day extend gently from the shoulders in dorso-lumbar fracture, and from the chin and occiput in cervical fractures. Extension may be maintained permanently until cure. Prof. White says laminectomy should be performed for fracture or for dislocation when there is obvious depression of the vertebral arches; in all cases of pressure upon the cauda equina; when there are characteristic symptoms of spinal hemorrhage; and in some cases where rapid degeneration becomes manifest.

Operations on the Spine: Treves's Operation for Vertebral Caries.—(See p. 479.)

Laminectomy.—The instruments required in laminectomy are dissecting-, rat-toothed, and hæmostatic forceps; scalpels; bone-cutting forceps; rongeur forceps; a trephine; a dry dissector; a periosteum-elevator; sequestrum forceps; small scissors, straight and curved on the flat; a chisel and mallet; retractors; blunt hooks; a probe; tenaculum forceps; a spoon-curette; a sand pillow; fine needles, curved and straight, large needles, and a needle-holder.

In the *operation* of laminectomy the patient lies prone and a sand pillow is placed under the lower ribs. Make an incision down the vertebral spines, the middle of the incision corresponding to the seat of fracture. The sides of the spinous process and the laminæ are cleared. The periosteum is incised in the angle between the laminæ and spines,

and it is lifted away from the arch. The spinous processes are cut off with forceps close to their bases, the laminæ are divided on each side with the rongeur, and the dura is exposed. In some cases the fragments will be found on exposing the vertebræ, or the blood-clot will be seen between the dura and the bone; in other cases the dura must be opened with scissors vertically in the middle line while it is grasped with rat-toothed forceps. After reaching and removing the compressing cause, or after failing to find or remove it, close the dura with catgut, drain the length of the wound with a tube, stitch the superficial parts with silk-worm gut, and dress antiseptically.[1]

XXIV. SURGERY OF THE RESPIRATORY ORGANS.

1. Diseases and Injuries of the Nose and Antrum.

Foreign bodies in the nose are usually introduced through the anterior nares, but in rare instances they enter by way of the posterior nares. Small particles are often expelled spontaneously; larger pieces gather mucus and become fixed. Some materials swell after lodgment.

Treatment.—Illuminate the nostril, and, if the foreign body can be seen, insert a hook back of it and effect its removal by means of forceps. In many cases anæsthesia is required. Some foreign bodies require to be pushed back into the naso-pharynx. Occasionally expulsion may be effected by inserting a rubber tube into the unblocked nostril and telling the patient to blow forcibly through it. In serious cases a specialist should be summoned to remove a portion of the turbinated bone or to perform whatever operation he thinks best.

Inflammation and Abscess of the Antrum of High-

[1] See J. W. White's admirable description in the *Annals of Surgery*, July, 1889.

more (Maxillary Antrum).—The source of this disease may be inflammation of the nose or periostitis around the roots of the teeth. The *symptoms* are pain, œdematous swelling of the face, and thinning of the bone so that it crepitates under pressure. When pus exists, certain positions of the head will cause a purulent flow from the nose, and pus may be seen by a speculum as it flows into the nose. In severe cases the jaw expands, the eye protrudes, and great tenderness of the alveolus exists. Percussion exhibits a dull note. In the diagnosis it may be well to employ an electric light in the closed mouth and note the limitations of light-transmission.

Treatment.—Before pus forms, leech and use hot fomentations. When pus has formed, evacuate it at once. If the disease arises from a carious tooth, pull the tooth and push a trocar through its socket into the antrum. If the teeth are sound, bore a hole with a large gimlet or with a bone-drill above the root of the second bicuspid tooth and one inch above the edge of the gum. A counter-opening should be made into the inferior nasal meatus. A drainage-tube is pulled from the first opening into the nose and is allowed to protrude from the nostril. Irrigate daily with peroxide of hydrogen. In three or four days discontinue through-and-through drainage, but prevent the first opening from closing until the discharge ceases to be purulent.

2. Diseases and Injuries of the Larynx and Trachea.

Œdema of the Larynx (Œdema of the Glottis).—The *causes* of œdema of the larynx are—acute laryngitis; chronic diseases, such as tuberculosis or syphilis; inflammatory disorders, such as diphtheria and erysipelas; acute infectious diseases; Bright's disease; aneurysm; whooping-cough; pneumonia; quinsy; wounds of the larynx; wounds of the neck; scalds and burns of the larynx. The *symptoms* are

sudden and rapidly increasing dyspnœa, respiratory stridor, huskiness of the voice, and finally aphonia. The epiglottis may be felt with the finger and may be seen with a mirror.

Treatment.—In cases of œdema of the larynx which are not excessively acute, make multiple punctures into the epiglottis and favor bleeding by the inhalation of steam. In severe cases perform intubation or tracheotomy.

Wounds and Injuries of the Larynx.—The larynx may be injured internally by foreign bodies, and externally by blows and cuts. A condition often met with is *cut throat*, the result usually of a suicidal attempt on the part of the patient or a homicidal effort on the part of an assailant. The cut of the suicide is usually in front; it misses the great vessels, but divides the crico-thyroid or thyro-hyoid membrane. The epiglottis may be incised, or even be cut off. If a large vessel is cut, death rapidly occurs. The immediate dangers of cut throat are hemorrhage, suffocation by blood, entrance of air into veins, and suffocation by displacement of parts. The secondary dangers are pneumonia, infection and sepsis, exhaustion, and secondary hemorrhage. The remote dangers are stricture and fistula (Keetley).

Treatment.—In wounds of the throat, arrest hemorrhage, remove clots from the larynx and trachea, bring about reaction, asepticize the parts as well as possible, suture the deeper structures with catgut and the superficial parts with silkworm gut, dress antiseptically, and place a bandage around the head and chest, so as to pull the chin toward the sternum. If laryngeal breathing is much interfered with, perform tracheotomy. Feed the patient through a tube until union has well advanced. The old method of leaving the wound open is to be condemned. When sutures are used, primary union may be obtained.

Foreign Bodies in the Air-passages.—The lodgement of foreign bodies in the air-passages is a frequent accident.

Small solid bodies are usually expelled by coughing. Liquids and solids rarely pass beyond the larynx (except in laryngeal disease or palsy, wounds of the floor of the mouth, cut throat, and in people unconscious or comatose). In post-ether vomiting or in the vomiting of drunkards the vomited matter may find its way into the larynx. In most instances of foreign bodies lodged in the air-passages it will be found that the object was being held in the mouth when a sudden deep inspiration was taken (often from laughter). The *symptoms* are *immediate*, due to obstruction by the body and to spasm, and *secondary*, due to the situation of the body and the changes it undergoes or induces.

Lodgement in the pharynx causes violent dyspnœa. The body can be seen or felt.

Lodgement in the Larynx.—In a severe case the patient fights madly for air; his face becomes livid and cyanotic; his veins stand out prominently; speech is impossible, though he may make noises and utter harsh cries; violent coughing begins, and then vomiting; he tries to force a finger down his throat and clutches at his neck; sweat pours from him; he feels a sense of impending dissolution, and he falls down unconscious, with incontinence of feces and urine.[1] In a less severe case violent dyspnœa gradually departs and the patient lies exhausted, but dyspnœa and cough are liable to recur suddenly at any time because of spasm, and they may be induced by a change of position. These attacks of fierce spasmodic cough are not at first linked with expectoration, but after inflammation begins there is a profuse and often bloody expectoration. Inflammation follows more rapidly the lodgement of a sharp or irregular body than it does that of a round or smooth body. Inflammation is apt to produce œdema of the glottis, broncho-pneumonia, or ulceration and necrosis of the larynx.

[1] See C. Mansell Moullin's graphic description.

Any foreign body in the larynx may at any moment produce spasmodic dyspnœa, and it is always very liable to cause œdema of the glottis.

Lodgement in the Trachea.—The immediate symptoms of foreign bodies in the trachea depend on the shape and weight of the body, and whether it becomes fixed in the mucous membrane or moves to and fro with the air-current. A smooth heavy body falls to the bifurcation, and, if it does not enter a bronchus, moves with every breath, and by its movement causes violent laryngeal spasm, cough, and whooping inspiration without aphonia. The patient is often conscious of the movements of the foreign body, and the surgeon may detect them with the stethoscope. A foreign body in the trachea is liable to cause death by dyspnœa, or it may ascend so as to be caught in the larynx, or may even be expelled. Irregular or sharp bodies lodge in the mucous membrane, produce inflammation, frequent cough, and expectoration, and finally lead to ulceration. Bodies which swell up from heat and moisture tend to lodge and to become fixed (seeds may sprout).

Lodgement in a Bronchus.—Foreign bodies in the bronchi usually lodge in the right bronchus. When a small lung-area is obstructed, the obstructed side shows diminished respiratory movement and murmur with occasional whistling sounds and large moist râles; percussion note is normal. When an entire lobe is obstructed, all respiratory sounds are absent over it, and over the unobstructed lung respiration is exaggerated; the percussion note, at first resonant, becomes dull. Lodgement in a bronchus may cause broncho-pneumonia, abscess, hemorrhage, and even gangrene.

Treatment.—If a foreign body lodges in the pharynx, try to pull it forward; if this fails, push it back into the œsophagus. In lodgement in the larynx or below, if the symptoms are very urgent, at once perform a quick laryngotomy. If

the symptoms are not so urgent, get a complete history of the accident and find out the nature of the foreign body. Be sure a foreign body is retained in the respiratory tract, and determine what its situation may be. Often a skilful man can remove a foreign body from the larynx by means of forceps, a mirror being used for illumination. The fauces and upper portion of the larynx should have cocaine applied to them to lessen pain and spasm. If the surgeon fails in extraction by forceps, and laryngotomy has been performed, continue the search through the opening in the crico-thyroid membrane; if laryngotomy has not been performed, let it be done in the form known as *thyrotomy* (a vertical incision between the alæ of the thyroid cartilage, and the separation of these alæ to permit of exploration). After a thyrotomy suture the perichondrium with catgut. If the foreign body is in the trachea or in a bronchus, perform tracheotomy: this prevents suffocation from laryngeal spasm or œdema. The foreign body may be expelled; if it is not expelled, search the trachea and bronchi with Gross's forceps, with probes, with hooks, or with the finger. If the foreign body cannot be found, insert a tube, put the patient to bed, and maintain a moist atmosphere. If the foreign body be extracted, do not insert a tube (unless œdema of the glottis exists or is likely to come on), do not suture the wound, but cover it with moist gauze and let it heal by granulation. Morphia and sedative cough-mixtures are given. Gross says that, even when a foreign body has long been retained, an operation should be performed so long as the air-passages are not seriously diseased.

3. Operations on the Larynx and Trachea.

Tracheotomy.—The instruments required in this operation are the scalpel, dissecting-forceps, a dry dissector, hæmostatic forceps, scissors, a tenaculum, aneurysm-needle,

tubes, tapes, Pacquelin cautery, needles, needle-holder, a mouth-gag, tongue-forceps, foreign-body forceps, retractors, and, if membrane is present, feathers and a solution of bicarbonate of sodium. In a formal operation give chloroform, but in an emergency case this cannot be done. The patient may be placed supine with a sand pillow under the neck and with the head thrown over the end of the table. In a child, Liston would wrap it up to the neck in a sheet to prevent movements of the limbs, would seat himself on a chair, place the child upon the nurse's lap, and take its head between his knees. If bleeding is profuse when the surgeon

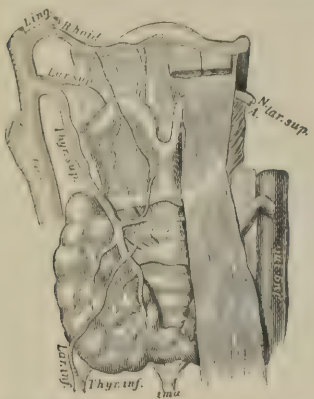


FIG. 137.—Blood-supply of the Larynx and Trachea (Esmarch and Kowalzig).

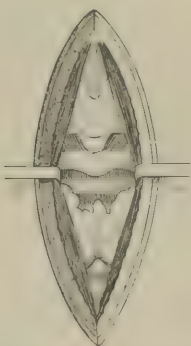


FIG. 138.—Parts Exposed in Tracheotomy (Esmarch and Kowalzig).

is ready to open the trachea, place the patient in the Trendelenburg position with the neck extended. The head must be exactly in the middle line, and extended (in an adult this gives two and three-quarter inches of trachea above the manubrium; in a child of ten, two and a quarter inches; in a child of six, about two inches). The operator stands upon the right side when the patient is supine. The trachea may be opened above or below the isthmus of the thyroid gland. The isthmus in an adult usually lies over the second and

third rings (Fig. 137). The isthmus in a child usually lies over the first ring or even over the space between the cricoid cartilage and the first ring. The high operation is always performed except in cases where it is desired to search for a foreign body in a bronchus.

High Tracheotomy.—This operation is preferred because in this region the muscles are distinctly separated (Fig. 138), the main vessels of the neck and the inferior thyroid vessels are not encountered, the anterior jugular veins are small and have very few transverse branches, and the trachea is near the surface (Treves). Accurately locate the cricoid and thyroid cartilages. An incision is begun at the upper border of the cricoid cartilage, and is carried down precisely in the middle line for about one and a half inches. Treves advises the operator to steady the skin of the neck with the fingers of the left hand and to cut with the unsupported right hand (if the hand be supported the respirations will interfere with the operation). Incise the skin, the superficial fascia, and the anterior layer of the cervical fascia, separate the sterno-hyoid and sterno-thyroid muscles, and divide the fascia over the trachea. This fascia is attached above to the thyroid cartilage, and it divides below into two layers to invest the thyroid body and its isthmus. If veins are in the line of the incision, push them aside, but do not stop to apply a double ligature. Even if bleeding is profuse, as soon as the trachea is opened and air enters freely into the lungs venous congestion is relieved and bleeding is apt to cease. If hemorrhage be violent and the veins are not at once caught by forceps, it may be well to place the patient in the Trendelenburg position. Before opening the trachea, push the isthmus of the thyroid gland down; if it cannot be pushed down sufficiently, make a transverse incision through the fascia at the upper border of the cricoid cartilage, and lift the fascia, and the isthmus with it, off the trachea. Insert a tenaculum

into the cricoid cartilage in order to steady the tube. Turn the back of the knife toward the sternum, hold a finger on the blade to prevent too deep a cut being made, plunge the knife, like a trocar, into the mid-line of the trachea above the isthmus, and divide two or three rings. Do not remove the hook at this time. If a foreign body is present, try to remove it; if success attends the effort, no tube need be worn, but if the body is not found, use a tube. In croup or in diphtheria, remove membrane (by means of a feather and a solution of bicarbonate of sodium ℥ij, glycerin ℥j, water ℥x—Parke) and insert a tube. Grasp an edge of the cut with the dissecting-forceps, include the mucous membrane in the bite, bring the head erect, introduce the tube, and remove the tenaculum. Secure the tube by tapes, and suture the wound below the tube. Remove the tube at the first moment consistent with safety. In croup or diphtheria, put a screen around the bed; have the air moist by steam; remove the inner tube and clean every two or three hours at first; clean the outer tube, and the larynx and trachea whenever required, by means of a feather and Parke's solution. A steam spray-atomizer may very often be used with advantage.[1]

Quick laryngotomy must never be attempted upon a child under thirteen years of age, because of the small size of the crico-thyroid space before this age (Treves). In view of the difficulty of introducing a tube and of wearing it so near the vocal cords, laryngotomy should not be performed for croup, diphtheria, or for any condition in which a tube must be worn long. An incision an inch and a quarter long is made in the middle line, from above the lower edge of the thyroid cartilage to below the lower border of the cricoid. Divide the skin, superficial fascia, and deep fascia, separate the crico-thyroid and sterno-thy-

[1] See Mr. Jacobson's admirable comments upon the croup-tent and the after-treatment of tracheotomy.

roid muscles, divide the deep layer of fascia, and divide the crico-thyroid membrane horizontally just above the cricoid cartilage. The tube must be shorter than is the tracheotomy-tube. An operation which opens vertically the crico-thyroid membrane, the cricoid cartilage, and the upper rings of the trachea is called "laryngo-tracheotomy."

Intubation of the Larynx (O'Dwyer's Operation).—The instruments required in this operation are a mouth-gag, an instrument to hold the tube and introduce it, an instrument for extracting the tube, and a graduated scale. The collar of the tube has a perforation through which a piece of silk is fastened to draw out the tube. The child is wrapped in a sheet to secure the limbs, is seated in a nurse's lap, and its head is held by an assistant. Open the jaws and insert the self-retaining mouth-gag. The surgeon sits in front of the patient, wraps the index finger of his left hand with plaster, and passes it into the child's mouth until his finger touches the epiglottis. Introduce the holder and tube (observing if the silk is free) along the surface of the tongue until the obturator touches the epiglottis; raise the epiglottis with the left index finger, and pass the tube into the larynx; place the left index finger against the tube, and withdraw the holder with the right hand. Tie the silken thread to the ear, and direct the nurse to employ it to remove the obturator if it becomes obstructed or is coughed up. Remove the tube in two or three days; if breathing is easy, do not reintroduce it, but if dyspnœa recurs, replace the tube for two or three days more. If, in introducing the tube, a mass of false membrane is pushed before it into the trachea, breathing ceases, and, if the mass is not at once coughed up, tracheotomy must be performed. Wharton feeds these patients on semi-solids rather than upon liquids (mush, soft eggs, and corn-starch), and if trouble occurs in swallowing these articles, he feeds by the rectum or by means of a tube (Wharton).

4. Diseases and Injuries of the Chest, Pleura, and Lungs.

Pleuritic effusion may arise from foreign bodies, from injury by fragments of a broken rib, from tumors, and from inflammation of the lung, but most usually from pleuritis. Inflammatory effusion is nearly always unilateral (except in tubercular pleurisy, which is one-sided at the start).

The *signs* of pleuritic effusion are—dulness on percussion over the effusion, this dulness, when the patient is erect, being at the lower part of the chest and ascending higher posteriorly than anteriorly (alteration of position alters the situation of the dulness); the intercostal spaces are widened and the intercostal depressions are obliterated; no breath-sounds can be detected in the area of flatness when the collection of fluid is large, but in small effusions deeply situated the breath-sounds are often audible; the percussion note above the liquid is hyper-resonant or tympanitic, and is often associated, at the edge of the liquid, with a friction sound; posteriorly, high up and near the spine, there is bronchial respiration and bronchophony (Prof. DaCosta). In these cases pain disappears with the advent of effusion, dyspnœa comes on, and the patient lies upon the diseased side. Cough and fever always exist. In serous effusions the diagnosis may be confirmed by the introduction of an asepticized hypodermatic needle. The *treatment* in this stage is to discontinue arterial sedatives and to stimulate if the circulation calls for it. The exudation is removed by salines, by compound jalap powder, or by elaterium. If these means fail, if the effusion is excessive, if it is producing dyspnœa, or if pus forms, at once aspirate.

Empyema is a collection of pus in the pleural cavity. Among the causes of empyema are those of serous effusion. The *signs* are dulness on percussion, as in serous effusion,

fever, chills, bulging of the intercostal spaces, and œdema of the skin of the chest. The *treatment* is aspiration or incision and drainage.

Contusions and Wounds of the Chest.—The symptoms of *contusions of the chest* are pain and soreness, and, as a consequence, abdominal respiration and decubitus upon the back inclining to the injured side. In severe contusions the viscera may be injured. The *treatment* is by strapping the chest as for fractured ribs (Pl. 7, Fig. 13). *Non-penetrating wounds* of the chest, which are not especially grave, are treated according to general rules, the chest being immobilized. *Penetrating wounds* are very grave and serious. Visceral injury may be inflicted. Emphysema is apt to occur. Hæmoptysis indicates a wound of the lung. In examining chest-wounds, feel with a finger, not with a probe. In wounds of the pleura, cleanse, stitch the pleura with catgut or fine silk, suture the skin, dress with gauze, and immobilize the chest. Wounds of the lung demand absolute rest. Always arrest hemorrhage. In hæmothorax, if the effusion causes intense dyspnœa, turn out the clots and drain. If emphysema of the chest-walls is moderate, strapping or a bandage will control it; if it is great, make multiple punctures and then apply pressure. In hernia of the lung, try to restore the protrusion, but if restoration is impossible or if gangrene seems highly probable, ligate the base with silk and cut away the mass. If foreign bodies in the thorax can be felt, remove them; if they cannot be felt, do not conduct a prolonged search, but leave them to Nature.

Paracentesis Thoracis.—The trocar must not be used except in an emergency; the aspirator (Fig. 96) is greatly to be preferred. The aspirator evacuates the fluid, and, as air does not enter, the lung expands and infection does not occur. The skin, the instruments, and the surgeon's hands must be asepticized. Give the patient a little whiskey, and,

unless he is very weak, make him sit up in bed. The arm hangs by the side, and the surgeon introduces the needle in the fifth interspace, just in front of the angle of the scapula. The surgeon marks the upper border of the sixth rib with the index finger, and plunges in the needle just above the finger, thus avoiding the intercostal artery, which lies along the lower border of the rib above. Always guard the needle with a finger to prevent its going in too far. After withdrawing the needle, place iodoform collodion over the opening in the chest. When the fluid is purulent, tapping rarely proves curative except in the empyemas which follow pneumonia in children. In pleuritic effusion, if the lungs will not expand after tappings, perform thoracotomy.

Thoracotomy is an incision into the cavity of an empyema. The instruments required are a scalpel, a grooved dissector, forceps (hæmostatic and dissecting), scissors, a dry dissector, retractors, bone-instruments (in case rib-excision is required), drainage-tubes, and needles. Chloroform is given the patient, who lies supine at the edge of the table, with the arm elevated to a right angle with the body. Make an incision about three inches in length along the upper border of the lower rib bounding the space it is proposed to penetrate. This space is either the sixth or the seventh, and the desired site is in front of the posterior axillary fold. Incise the skin, divide the intercostal muscles near the rib, push a grooved director through the pleura, and enlarge the opening by means of forceps and the finger. The finger removes all masses of tubercular material or aplastic lymph within reach. Against washing the cavity at once on operation is the great author-

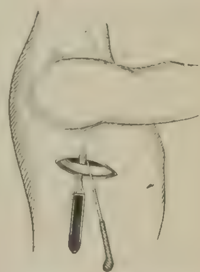


FIG. 139.—Resection of Rib (Esmarch and Kowalzig).

ity of Treves, but many able surgeons advocate immediate irrigation. In some cases a counter-opening is made by cutting down upon the long probe which is pushed against the chest-wall after being introduced through the incision; in other cases it is necessary to resect a rib (p. 499; Fig. 139). A short drainage-tube is introduced and stitched in place. If a counter-opening has been made, introduce another short tube, but do not pull a tube through both openings. Arrest bleeding, suture the skin, dust with iodoform, dress with gauze, wood-wool, and a binder, and have the dressings changed as soon as they become soaked at one point. After a day or so has passed, wash out the cavity once every twenty-four hours. Use a fountain-syringe. Irrigate first with warm diluted peroxide of hydrogen, and then with hot corrosive-sublimate solution (1 : 1000) or with a hot solution of tincture of iodine (1 : 1000).

Thoracoplasty (Estlander's operation) is employed in old cases of empyema in which drainage has failed, and in cases with retracted chest-walls, collapsed lungs, thickened pleura, and cavities whose rigid walls will not collapse. This operation causes the obliteration of the cavity by collapsing that portion of the chest-wall overlying it. The cavity is in the upper or central part of the pleural space (Treves). The instruments required are the same as those for resection of a rib. The position is the same as that for rib-resection. The length of the incision depends on the size of the cavity. The surgeon usually removes portions of the second, third, fourth, fifth, sixth, and seventh ribs. Make a transverse incision along the centre of an intercostal space, and through this incision remove the ribs above and below by the method set forth on page 499 (the removal of six ribs will require three incisions). Always take away the periosteum. Treves recommends that the cavity be at once washed out with corrosive sublimate (1 : 1000); that, if small,

it be packed with iodoform gauze and allowed to granulate; that, if large, it be drained by a large tube, the skin being sutured by silkworm gut.

XXV. DISEASES AND INJURIES OF THE DIGESTIVE TRACT.

Diseases of the Mouth, Tongue, and Œsophagus: Hare-lip and Cleft Palate.—*Hare-lip* is a congenital cleft in the upper lip. *Cleft palate* is a congenital fissure in the soft palate or in both the hard and soft palates. In hare-lip the cleft is usually complete, through the entire lip into the nostril, but in rare cases it may only show as a furrow in the mucous edge or as a split from the nostril partly into the lips. In double hare-lip the central portion of the lip is often adherent to the tip of the nose (Bowlby). Median hare-lip is exceedingly rare. In cleft palate the septum of the nose is usually adherent to the palatine process opposite to the side upon which the fissure exists. In those rare cases of cleft palate double in front the nasal septum is attached only to the premaxillary bone, and the premaxillary bone is not attached at all to the superior maxillæ. In hare-lip there is often a cleft in the alveolus, and almost always flattening of the corresponding side of the nose. Hare-lip is often associated with cleft palate, talipes, and other deformities. It is a great deformity, and interferes with suckling, swallowing, and articulation.

Operation for hare-lip should be performed between the third and sixth months of life in a child in good health, free from stomach trouble, cough, or coryza, but operation is not advisable in the early weeks of life. Always, if possible, operate before dentition begins (seventh month). If the child is in poor health, postpone the operation until restoration has so far advanced as to render operation safe. If a

cleft exists in the palate, operate first upon the lip, because the pressure of the parts after the edges of the gap are approximated aids in the closure of the bony cleft. Cleft palate interferes with suckling, deglutition, mastication, and articulation. In severe cases the food passes into the nose and excites inflammation. Loss of control of the palate-muscles always exists, and liquids and solids are liable to pass into the windpipe. Clefts in the hard palate should not be operated on until the tenth or twelfth year unless the child is unable to take sufficient nourishment. In most cases the passage of food and drink into the nose can largely be prevented by the use of a diaphragm. The patient at the period of operation should be well and free from cough (the elder Gross).

Operation for Hare-lip.—The instruments required are a tenotome, hare-lip clamps, toothed forceps, hæmostatic forceps, scissors curved on the flat and pointed, straight blunt-pointed scissors, needles (straight and curved), silk-worm-gut and silk sutures, a mouth-gag and tongue-forceps, a needle-holder, and sequestrum forceps, each blade protected by a rubber tube. Wrap the child in a sheet; place it supine; raise the head and rest it upon a sand pillow. The surgeon stands to the right-hand side. Ether or chloroform is given. For single hare-lip, separate with the scissors the upper lip from the bone on each side of the cleft until approximation of the cleft can be effected without tension. If the maxillary bone of one side projects more than its fellow, grasp it with sequestrum forceps and bend it back (Jacobson and Treves). Put a compressor in each angle of the mouth. Grasp the lower angle of one flap with dissecting-forceps and pare the edge; carry out the same procedure

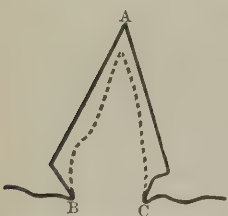


FIG. 140.—Operation for Hare-lip.

upon the other flap (Fig. 140). The edges are approximated by an assistant, and silkworm-gut sutures are passed by means of a straight needle. Each suture goes down to the mucous membrane. The first suture is passed through the middle of the lip, one-third of an inch from the cleft. Three or four main sutures are passed through the thickness of the lip, and are tied and cut off. Two or three fine silk sutures are passed by curved needles through the vermilion border of the lip and its mucous membrane, and are tied and cut off. A small piece of gauze is placed over the lip and is held in place by straps of rubber plaster. About the sixth day one-half the sutures are taken out, and on the eighth or ninth day the remaining ones are removed. Hare-lip pins are rarely used at the present time, and are not needed if the lip is well separated from the bone.

In double hare-lip the operation is similar to that for single hare-lip. If the intervening piece is vertical and is covered with healthy skin, complete each operation as for single hare-lip, closing both fissures at once in a strong, healthy child, closing them at intervals of three weeks in one not so lusty. Excise the septum if it is deformed. The premaxillary bone should in most instances be removed, the skin over it being preserved. Sir. Wm. Fergusson was accustomed to incise the mucous membrane and shell out this bone. The premaxillary bone can be forced back into line, being held, if necessary, by catgut suture of the periosteum; but if saved it is liable to necrose and its teeth soon decay. Figure 141 shows incisions for double hare-lip.

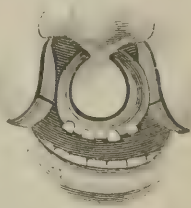


FIG. 141.—Incisions for Double Hare-lip (Esmarch and Kowalzig).

Operation for Cleft Palate.—Early operations are very dangerous in bony clefts, and during the early years of

growth the clefts diminish in size. Bony clefts should be operated upon about the twelfth year. Clefts of the soft palate only may be operated upon in the third year (Thomas Smith). For *closure of the soft palate* (*staphylorrhaphy*) Treves says the following instruments are essential: Two sharp-pointed tenotomes, a blunt-pointed tenotome, a rectangular knife, two pairs of long forceps (one with tenaculum points, one serrated), a fine hook, a pair of sharp-pointed curved scissors, scissors curved on the flat, periosteum-elevators, two long-handled needles with eyes at their points, a suture-catcher, a tubular needle for wire sutures, hæmostatic forceps, Whitehead's gag and retractors, silver wire, silkworm gut, and sponge-holders; also an electric forehead light. The patient's body is raised, and his head is elevated and rested upon a sand-bag. A better position would be that of Trendelenburg, thus avoiding the blood trickling into the windpipe. Chloroform is given. The gag is introduced; the edges of the fissure are pared with the tenotome; the sutures are introduced from below upward, silkworm gut being used for the uvula and lower part of the velum, silver wire for the remainder of the cleft; each suture, as it is passed, is tied or twisted, but is not cut until the next suture is inserted, thus serving as a handle. If there is too much tension to allow of the sutures being tied as they are inserted, all the sutures are passed and loosely twisted; a longitudinal incision is made upon each side, internal to the hamular process, the mucous membrane being cut with the sharp tenotome, the deeper structures being divided with a blunt tenotome; the sutures are tied or twisted and cut (Fig. 142). In *Fergusson's operation* for clefts in the hard palate (*uranoplasty*) the mucous edges are pared and the sutures inserted but not tied. Make an incision upon each side down to the bone, the incision being midway between the cleft and the alveolus. Divide the bone on each side, by means of a chisel, to the

full length of the incision, and, using the chisel as a lever, force each half of the bone toward the gap. Tie the sutures, and plug each lateral incision with a piece of iodoform gauze (Fig. 143). After the operation for cleft palate, put the patient to bed for one week; forbid talking; give fluid or semi-solid food for three weeks at intervals of two or three hours;

FIG. 142.—Staphylorrhaphy (Esmarch and Kowalzig).

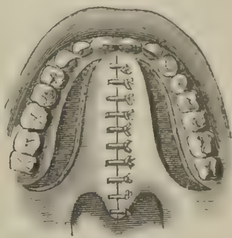


FIG. 143.—Uranoplasty (Esmarch and Kowalzig).

wash out the mouth very often (always after eating) with a carbolic solution (1 : 100) or a solution of boracic acid and listerine. Sutures are removed in from two to three weeks.

Tongue-tie is a congenital shortness of the frænum. The tongue cannot be protruded beyond the incisor teeth. Swallowing is interfered with, and later in life articulation is impeded. To treat tongue-tie, tear up the frænum with the thumb-nail. If this fails, catch the frænum in the slit in the handle of a grooved director, push the director toward the floor of the mouth, and divide the frænum with scissors curved on the flat and pointed toward the director.

Ranula is a dilatation of one of the ducts of the mucous glands of Nuhn and Blandin. These glands lie on each side of the frænum of the tongue. It was long thought that a ranula arose from obstruction in the duct of the sublingual gland. A ranula appears upon the floor of the mouth on one side and pushes the tongue toward the opposite side. The contents of a ranula resemble mucus or saliva. The

treatment of ranula is by the seton; by excision of a portion of the cyst-wall and cauterization of the interior with pure carbolic acid or with 15 minims of a solution consisting of 10 parts of tincture of iodine, 10 parts of water, and 1 part of iodide of potassium; or by cutting a flap from the cyst-wall and stitching it aside so as to keep a permanent opening.

Excision of Tongue (Kocher's Method).—Kocher used to employ a preliminary tracheotomy in tongue-excision, but the Trendelenburg chair renders this procedure unnecessary so far as hemorrhage is concerned. Always clean the mouth well. The instruments required are a scalpel, retractors, a dry dissector, hæmostatic and dissecting-forceps, a tenaculum, aneurysm-needle, tenaculum forceps, needles, sutures, and scissors. In this operation the patient is placed in the Trendelenburg position, the surgeon being on the affected side. Chloroform is given. An incision is made from behind the lobe of the ear, along the anterior edge of the sterno-cleido-mastoid to about the middle of the margin of this muscle. From this point the incision is carried to the hyoid bone and then to the symphysis menti, along the anterior belly of the digastric muscle (Fig. 144). The flap is dissected and turned up; the facial and lingual arteries are ligated; "the submaxillary fossa is evacuated" (Treves); the sublingual and submaxillary glands are removed; the mylo-hyoid muscle is divided; the mucous membrane is incised close to the jaw, and the tongue, caught with tenaculum forceps, is drawn through the opening. Split the tongue in the middle with scissors, and remove the near half. If the whole

FIG. 144.—Excision of Tongue (Esmarch and Kowalzig).

tongue requires removal, perform a set ligation of the lingual artery of the opposite side. Arrest bleeding. Some surgeons stitch the mucous membrane of the stump to the mucous membrane of the floor of the mouth; others employ no sutures. Kocher does not suture his skin-wound; other surgeons do, and employ drainage-tubes. Keen advises closing the floor of the mouth if possible. Some hours after the operation, when oozing has ceased, dust the mouth-wound with iodoform. The patient, as soon as possible, is propped up in bed, and he must not swallow the discharges if it can be avoided. The mouth, every half hour, is sprayed out with peroxide of hydrogen and washed with a carbolic solution (1 : 60); every three hours, after a washing, the floor of the mouth and the stump are dried with absorbent cotton and dusted with iodoform. For twenty-four hours after the operation nothing is given by the mouth except a little cracked ice, the patient being fed per rectum. At the end of twenty-four or forty-eight hours some liquid food is given by a feeding-cup. The patient will soon learn to swallow, but if he cannot swallow, feed him with a tube. Treves, in his clear and positive directions for after-treatment, states that nutrient enemata are to be continued until sufficient nourishment is taken by the mouth; that the mouth should be flushed out by irrigation, and must be washed immediately after taking food; that morphia is to be avoided; and that the patient can usually leave the hospital in from seven to ten days.

Stricture of the Œsophagus.—*Fibrous* or *cicatricial* stricture is due to a wound, to swallowing a corrosive substance, or to syphilis. It is commonest in the young, and is apt to be situated opposite the cricoid cartilage. *Malignant* or *cancerous* stricture, which arises in those beyond middle life, is more common in men than in women. It is usually due to epithelioma, and its most usual site is on a

level with the cricoid cartilage. It is invariably fatal, usually by means of septic pneumonia or starvation. *Spasmodic* or *hysterical* stricture, which is commonest in women, is associated with the stigmata of hysteria, and especially with globus (a sense as of a ball rising in the throat); a bougie held against it is only temporarily obstructed. The contraction arises suddenly, and one passage of a bougie often causes it to disappear.

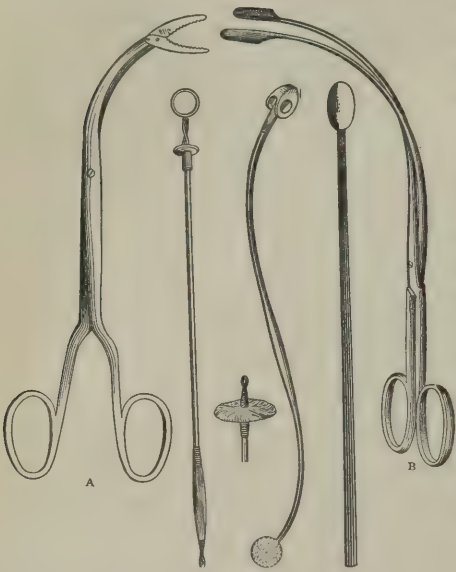


FIG. 145.—Operating Instruments: A, B, forceps; C, horsehair probang; D, coin-catcher; E, œsophageal bougie (Esmarch and Kowalzig).

Symptoms and Treatment of Organic Stricture.—Difficulty of swallowing, emaciation, regurgitation of food which was apparently swallowed (because of dilatation above the stricture). Auscultation as fluid is being swallowed will locate the obstruction. The bougie makes the diagnosis (Fig. 145, E). In fibrous stricture, feed the patient on liquid food and on food cut up into very small pieces. Pass a bougie every day, gradually increasing the size. In cancerous stricture bougies are dangerous; if they are passed, it must be very gently. The passage daily of a soft-rubber catheter maintains an open way. Feed upon liquids, through a tube if necessary, and when this becomes difficult or impossible, perform gastrostomy. Symonds advocates permanent

tubage of strictures. The younger Gross advocated a course of iodide of potassium in stricture, because of the possibility of syphilis. The operation of œsophagostomy has been undertaken, but with poor success. Excision of the diseased portion of the œsophagus has been practised.

Foreign Bodies in the Œsophagus.—A large foreign body in the œsophagus is apt to be arrested at the smallest part of the tube, opposite the cricoid cartilage. Foreign bodies are frequently caught where the gullet is crossed by the left bronchus and also where it passes through the diaphragm. Small and sharp bodies may lodge anywhere.

Symptoms and Treatment.—If the body is large, there will be pain and difficulty in swallowing, and, in some cases, dyspnœa. If the body is sharp, there will be hemorrhage and severe pain. A patient may grow accustomed to a foreign body, and cease to notice it; but, on the contrary, the foreign body may produce inflammation, and even may ulcerate into the windpipe, the pleura, the pericardium, or the aorta. Even after a foreign body has been removed by swallowing or otherwise, a sensation is apt to remain as if it were still lodged. The diagnosis in children or lunatics is made by the detection of the body by external manipulation and by feeling it with an œsophageal bougie. A round smooth body is grasped with forceps and pulled out, or, if this is impossible, it is pushed down with a probang. Sharp bodies are removed with a horsehair probang (Fig. 145, C). Coins are removed with a coin-catcher (Fig. 145, D). Various forceps are employed (Fig. 145, A, B). Vomiting sometimes displaces a foreign body. In rare instances œsophagotomy is demanded, the cut being made on the left side, between the trachea and the larynx in front and the carotid sheath behind, the centre of the incision being opposite the cricoid cartilage. After removing the foreign body, suture the

œsophagus with catgut and feed the patient through a tube for one week.

XXVI. DISEASES AND INJURIES OF THE ABDOMEN.

Contusion of the Abdominal Wall.—In some cases of contusion of the abdominal wall only the parietes are contused; in other cases the viscera or the abdominal tissues are injured. In *simple cutaneous contusion* there is considerable shock if the injury is severe; there is pain, increased by respiration, and ecchymosis soon appears. In treating simple contusion, place the patient at rest in a supine position; obtain reaction from the shock; give morphia for pain; place an ice-bag over the injury from time to time, and in the intervals of its application use lead-water and laudanum locally. If much blood is extravasated, aspirate and apply a binder. After twenty-four hours apply intermittent heat by poultice, employ an ointment of ichthyol, and move the bowels, if necessary, by salines.

Muscular Rupture from Contusion.—In this injury there are severe shock and pain (increased by respiration and movement). Separation between the fibres of the muscle is distinct at first, but it is soon masked by effusion of blood. Such injuries may cause death, or they may lead to hernia.

The *treatment* is the same as for simple contusion. Always apply a binder. A hernia is returned and a compress is applied over the opening through which it emerged. If strangulation occurs, operate at once.

Rupture of the Stomach without External Wound.—The symptoms of this injury are—excessive shock; pain over the entire abdomen, especially over the epigastric region; and vomiting of blood if the mucous membrane is

torn. After *incomplete* rupture local peritonitis is frequent; in *complete* rupture the escape of food into the peritoneal cavity causes septic peritonitis. To diagnosticate between complete and incomplete ruptures, endeavor to distend the viscus with hydrogen gas: in incomplete rupture the contour of the dilated stomach can be made out upon the surface; in complete rupture the viscus cannot be distended and the gas passes into the peritoneal cavity, producing the physical signs of tympanites (Senn). The *treatment* in complete rupture is as follows: React from shock and at once open the abdomen; if the rent is not visible, find it by inflating with hydrogen; flush out the stomach and the peritoneal cavity; sew up the stomach-wound with a double row of silk sutures, the first row being buried and including the muscular coat and mucous coat, the second row being Lembert sutures; drain; close the wound in the parietes with silkworm gut; feed by the rectum for four days, and then begin the administration of a very little food by the mouth. In incomplete rupture the danger is perforation. The patient is put to bed, is reacted, is fed by the rectum for several days, and morphia is given hypodermatically.

Rupture of the Intestine without External Wound.— The symptoms of this injury are profound shock, tympanites, and pain, rapidly followed by peritonitis. Vomiting comes on soon after the accident, the vomited matters being at first bloody and then stercoraceous. The respiration is thoracic, the tongue is dry, and great thirst exists. The pulse, which is slow at first, becomes small and rapid. A high-tension pulse goes with tympanites, because the distention of the bowel greatly decreases the amount of blood in its coats, and thus increases the amount of blood in the rest of the system. Any portion of the intestine may rupture, but the ileum is most liable to this accident. Blood in the stools rarely appears early enough to be of diagnostic value. The

escape of gas into the peritoneal cavity may cause disappearance of normal liver-dulness. By anæsthetizing the patient hydrogen gas insufflated into the rectum will come from the mouth if there is no perforation in the stomach or the intestine; if a perforation exists, tympanites is much increased. To apply rectal insufflation of hydrogen, generate the gas in a bottle by means of zinc and sulphuric acid, catch the gas in a large rubber bag, and attach the tube from the gas reservoir to a tip which is inserted in the rectum. Give the patient ether to relax the abdominal muscles, direct an assistant to press the anal margins against the rectal tip, and when the patient is unconscious turn on the stopcock and press upon the reservoir (Senn).

Treatment.—Give stimulants by the rectum, and a hypodermatic injection of morphia and atropia; asepticize and anæsthetize. Perform a laparotomy; check hemorrhage; find the rent, and close it by Lembert sutures if possible. It may be necessary to perform an end-to-end approximation or an intestinal anastomosis. Flush out the abdominal cavity with cooled boiled water. The hydrogen-gas test will discover perforations.

"In abdominal operations it is frequently imperatively necessary that the large intestine be recognized with certainty or the small bowel be positively identified. The size of the tube will not always aid in this recognition, as a small intestine may be distended enormously and a large intestine may be contracted to the size of a finger because of obstruction above. The longitudinal muscular fibres of the large bowel are accentuated in three portions; these accentuations constitute the three longitudinal bands which begin at the cæcum and terminate at the end of the sigmoid flexure of the colon. Each band is composed of a number of shorter bands, the shortness of these constituent bands permitting the sacculation of the large intestine. Longitudinal bands

and sacculation are not met with in the small gut, their presence or absence being a means of identification in many cases; but when the colon is much distended the bands cannot be seen distinctly and the sacculation disappears. From the large intestine only spring the appendices epiploicæ (small overgrowths of fat in pouches of peritoneum), but they are sometimes not well marked except upon the transverse colon, and when emaciation exists they may almost entirely disappear. The relatively fixed position of the large intestine and the free mobility of the small bowel are important points of distinction. The foregoing indicates that it is not always easy to distinguish between colon and small gut, and that, according to old rules, it may often be necessary to make large incisions, to see as well as feel, and to handle a large extent of the bowel. Any scrap of knowledge that will shorten an abdominal operation, that will permit of as certain work through a smaller incision, and that will diminish handling of intraperitoneal structures, tends to increase the chances of recovery. For these reasons the writer suggests a method of bowel-identification which rests upon the facts that each bowel has a posterior attachment, that the origin of the attachment differs according to the bowel it supports, that a single finger can detect the origin of the peritoneal support of any section of the bowel, and, this origin being known, the portion of bowel it supports is with certainty deducible. In an exploratory operation, for instance, the finger comes in contact with the bowel: to determine whether it is a large or a small bowel, note first if the structure is movable or is firmly fixed; next, pass the finger over the bowel and let it find its way posteriorly. If dealing with a small bowel, the finger will reach the origin of the mesentery between the left side of the second lumbar vertebra and the right sacro-iliac joint; if dealing with the large bowel, the finger will reach the origin of the meso-

colon, or the point where the colon is fixed posteriorly and to the side."[1]

After flushing out the abdomen a drainage-tube is inserted and the wound is closed.

Wounds of the Abdominal Wall.—*Non-penetrating wounds* are to be treated on general principles. Suture with great care and apply external support. Ventral hernia may follow a large wound.

Penetrating Wounds.—The *symptoms* of penetrating wounds of the abdominal wall are usually those of shock and hemorrhage, and later of septic peritonitis. Emphysema is apt to occur. Viscera may protrude. In an incised or a lacerated wound some of the contents of the abdomen may protrude. If protruding viscera are uninjured, they are cleansed with cooled boiled water and returned into the abdomen, the wound being enlarged if necessary. The belly is flushed out with hot sterilized water to remove blood-clots, a drainage-tube is inserted, the peritoneum is sutured with catgut, and the muscles and integument are approximated with silkworm gut. If the viscera are injured, treat them appropriately. In punctured and in gunshot wounds, when the intestine has been perforated, rectal insufflation of hydrogen will often disclose the fact, but evisceration may be necessary. Always arrest bleeding. In punctured wounds enlarge the wound of entrance, examine for injury of viscera, close perforations if any are found, flush out the belly, drain, and close the wound. In gunshot wounds examine for a wound of exit; follow the track of entrance by means of a knife and a grooved director; open the peritoneum; arrest hemorrhage; look for perforations and close them; examine viscera; search for the ball, but not long, and if it is found, remove it; flush out the belly with hot sterilized water; dry with sponges; drain; and close the wound. In some

[1] The author, in *Medical News*, June 9, 1894.

cases of penetrating wounds of the abdomen enterectomy will be required, and also enterorrhaphy. Irrigation of the cavity is only required when the contents of the stomach or the bowel have escaped or when a considerable hemorrhage has taken place. The surgeon should drain when the contents of the stomach or the intestines have escaped, when hemorrhage is severe, or when the liver, pancreas, kidney, or spleen is damaged. Active stimulation and artificial heat are needed immediately after the operation, to combat shock. The after-treatment consists of rest, opium in small amounts to arrest peristaltic action, avoidance of food by the stomach for forty-eight hours, and the administration of brandy and water from time to time. Feed by the rectum for two days. On the appearance of the first sign of peritonitis forty-eight hours or more after the operation, give a saline cathartic. It will not do to purge during the first forty-eight hours after the operation. When there is no sign of peritonitis, do not purge until the fourth day. After forty-eight hours liquid food can usually be given by the stomach. Solid food may be given after seven or eight days, but the patient must not leave his bed until the wound is solidly united, because of the danger of ventral hernia. A support should be worn for a long time.

Foreign Bodies in the Alimentary Canal.—Most foreign bodies are passed with the feces. A purgative should *never* be given to expedite the passage of a foreign body, because increased peristalsis means increased danger of impaction or of perforation. Endeavor to encrust the foreign body, and thus lessen the danger of perforation, by feeding with bread and milk only for several days, and at the end of this period give a mild laxative. An exclusive diet of mush or of mashed potatoes has been suggested. If a foreign body lodges in the stomach, perform a gastrotomy.

Cancer of the Stomach.—*Surgical treatment* may aim at the excision of the growth, or may seek to remove the

mechanical impediment to the entrance of food into, or the emergence of food from, the stomach. In stricture of the cardiac orifice of the stomach the surgeon usually keeps the passage open as long as possible by the frequent passage of a tube, and through this tube introduces liquid food. Sometimes a small tube is introduced and permanently retained. If a tube cannot be introduced, gastrostomy is performed, and through this artificial opening the patient is fed (p. 635). In cancer of the pylorus limited in extent and without lymphatic involvement, pylorectomy may be performed; but in cancer which has widely infiltrated the coats of the stomach and has involved the lymphatic glands, gastro-enterostomy is performed as a palliative measure, the patient during the balance of his life subsisting upon liquid or semi-liquid foods and submitting to frequent irrigation of the stomach to remove food-residue. In cases of ineradicable cancer it is usually best to create the opium-habit.

Cicatricial stenosis of the orifices of the stomach results from the healing of an ulcer, the swallowing of a corrosive substance, or a traumatism from a foreign body. Constriction of the *cardiac orifice* is indicated by gradually increasing difficulty in swallowing. After a time the œsophagus above the stricture dilates or pouches; the fluid food passes into the stomach, but the solid food lodges in the œsophageal pouch and is soon regurgitated. The site of the stricture is located by a bougie. If the constriction be malignant, the patient will be found to be beyond middle life, a tumor may possibly be felt, the vomit is occasionally bloody, and emaciation is rapid and decided. If the constriction be cicatricial, the history will exhibit the cause. Constriction of the *pyloric orifice* causes retention of food and dilatation of the stomach. Dyspeptic symptoms will be found to have been long present. A tube passed into the stomach permits of the injection of fluid so as to fill the stomach. When the fluid runs out it

contains portions of undigested food eaten days before, and measurement of the liquid shows that the capacity of the stomach is enormously increased. If air be forced through the tube, the outline of the distended stomach is at once made clear. The usual method of distending the stomach is by a Seidlitz powder: two solutions are made; the bicarbonate solution is swallowed at once, and the tartaric solution is taken afterward in small amounts at a time.

Treatment.—Cardiac stenosis requires dilatation with bougies and the maintenance of the restored calibre. If this dilatation is unsatisfactory, perform a gastrotomy, push a small bougie from the mouth into the stomach, tie a string to the bougie, draw the string through the stricture, use the string as a saw to cut the fibrous bands, pass a full-sized bougie, close the wound in the stomach, and maintain the calibre by the repeated passage of dilating instruments. If no instrument can be passed through the stricture, perform a gastrotomy, introduce an instrument from below, and use Abbé's string saw. If no instrument can be passed from below, convert the gastrotomy into a gastrostomy. Pyloric stenosis is treated by a gastrotomy and digital divulsion of the stricture (Loreta's operation), by pyloroplasty (Heineke-Mikulicz operation), or by gastro-enterostomy.

Intestinal Obstruction (Ileus or Entero-stenosis).—Intestinal obstruction is a condition in which fecal movement is mechanically impeded or prevented. It may be either *partial* or *complete*. *Acute obstruction* is due to a sudden narrowing or occlusion of the lumen of a portion of the intestine. *Chronic obstruction* is due to a gradual narrowing of the lumen of a portion of the intestine, and it may at any time become acute. If obstruction to circulation in the wall of the bowel occurs, the condition becomes one of strangulation. Intestinal obstructions are classified[1] as follows:

[1] After Treves, in *Heath's Dictionary*.

1. *Strangulation by bands or in apertures*, the commonest form, is due to peritoneal adhesions, but the band may come from the omentum. Strangulation may take place by Meckel's diverticulum, a structure due to persistence of the vitelline duct, and coming off from the ileum from twelve to thirty-six inches above the ileo-cæcal valve. Strangulation may take place beneath an adherent appendix, a Fallopian tube, a portion of mesentery, or the pedicle of an ovarian tumor, or it may take place in an omental or a mesenteric aperture. Strangulation by bands or apertures usually involves the ileum, and sometimes the colon. This form of obstruction is identical with hernia excepting in the absence of an external protrusion.

2. *Volvulus*, or twisting of the bowel. The twist may be about the mesenteric axis or on the axis of the bowel itself, or two intestinal coils may be twisted together. Volvulus is commonest in the sigmoid flexure.

3. *Intussusception* is the invagination of a portion of bowel-wall into the lumen of an adjacent part. One-third of all cases of obstruction are due to this cause (Treves). There are four varieties: the *ileo-cæcal*, in which the ileum and the ileo-cæcal valve pass into the cæcum and colon; the *colic*, in which the large intestine is prolapsed into itself; the *ileal*, in which the small intestine alone is involved; and the *ileo-colic*, in which the ileum prolapses through the ileo-cæcal valve. The first variety is the commonest. Intussusception is due to active peristalsis.

4. *Stricture of the intestine*, which stricture may be either cicatricial or cancerous.

5. *Obstruction by Tumors of the Bowel and by Foreign Bodies.*—Tumors may be innocent or malignant. Foreign bodies include certain substances that have been swallowed, gall-stones, and enteroliths, or intestinal calculi. Foreign bodies are apt to lodge in the lower portion of the ileum or

in the cæcum, and they may cause ulceration at the seat of lodgement. If a gall-stone is sufficiently large to cause obstruction, it cannot have passed the duct, but must have ulcerated into the bowel from the gall-bladder (Treves).

6. *Obstruction by tumors, etc. outside the bowel*, among the causes of which are retroflexion or retroversion of the womb, especially in pregnancy, cysts or tumors of the kidneys, ovaries, uterus, etc., and enlarged spleen. Obstruction from any of the above causes takes place in the rectum or the sigmoid flexure.

7. *Obstruction from fecal accumulation* is due to paresis or paralysis of the bowel and the diminution or abolition of peristalsis. Paresis or paralysis arises in the colon. Treves mentions among the rare forms of obstruction kinking of the bowel, adhesions matting the bowels together or compressing the gut, and shrinking of the mesentery.

Symptoms of Acute Obstruction.—Severe colic comes on suddenly, the pain varying in intensity, but at no time entirely ceasing; there is constipation which soon becomes absolute, not even wind being passed; vomiting is early—first of the contents of the stomach, next of bilious matter, and finally of feces (stercoraceous); the abdomen becomes distended and tender; some fever may be found at the start, but collapse soon arises; the temperature is subnormal; the face is Hippocratic; the pulse is rapid and feeble; and the amount of urine passed is very small. In obstruction of the upper third of the ileum true fecal vomiting cannot occur. The tongue is dry, the mind is clear, and muscular cramp may occur. Intestinal peristalsis above the obstruction may be detected through the abdominal wall. If obstruction is high up in the small intestine, tympanites does not occur.

Symptoms of Chronic Obstruction.—At intervals there arise attacks of pain which become gradually more frequent and severe and are linked with vomiting and constipation,

the vomiting not being stercoraceous and the constipation not being absolute. Between the painful seizures the patient complains of constipation alternating with fluid diarrhœa, distention of the belly, some abdominal uneasiness, anorexia, and dyspepsia. The attacks recur with increasing frequency and severity, and acute obstruction may arise or the patient may be worn out by pain, vomiting, and want of food.

Diagnosis.—*The determination of the seat of lesion* requires rectal examination. An intussusception may sometimes be felt. Vaginal examination may be demanded. Pain is apt to arise at the seat of obstruction or to radiate from there. Palpation may detect a tumor. Rectal insufflation of hydrogen may locate the obstruction by causing great distention below it. Entire suppression of urine, early vomiting which is not truly stercoraceous, absence of abdominal distention, and rapid collapse, mean obstruction in the duodenum or in the jejunum. Early vomiting, which is often stercoraceous in a rapidly progressive case with great distention of the umbilical region, means obstruction of the ileum or the cæcum (Pepper). Distention of the entire abdomen and of the flanks, linked with tenesmus, with less intensity of symptoms, less rapidity of progress, and less diminution of urine than in the above-cited forms, means obstruction low down in the colon or in the rectum (Pepper). A test for obstruction in the adult large intestine is an injection by a fountain syringe: if six quarts can be introduced, there is no obstruction in the large intestine; if less than four quarts can be introduced, there is probably obstruction in the large intestine. The passage of a sound in the rectum is generally useless and is often unsafe.

The determination of the causative condition is always difficult and is often impossible. Intussusception is the common cause in children. A tumor can usually be felt in the right iliac fossa, tenesmus exists, and bloody mucus is passed.

The abdomen is rarely distended or tender. Vomiting occurs, but it is seldom stercoraceous. The prolapse may be detected by a finger in the rectum. In obstruction from bands, internal hernia, etc. there is a record of peritonitis, of a traumatism, of a violent effort, or of pelvic pain. The attack is sudden in onset, is fierce in character, and is usually excited by violent exercise or the taking of food. Vomiting is early and intractable, and it soon becomes stercoraceous; pain is violent; tympanites and abdominal tenderness appear after the attack has lasted for some little time; obstruction is complete, no wind even being passed; collapse soon appears; no tumor can be detected, and rectal examination is negative. Volvulus, which is usually located in the sigmoid flexure, is preceded by constipation. The symptoms come on with explosive suddenness, and rapidly attain great severity. Constipation is absolute; vomiting is late and is rarely stercoraceous; no tumor can be detected; rectal examination is negative; abdominal distention and tenderness are early and pronounced; collapse is not so rapid or so grave as in the previously-considered forms. Obstruction by a foreign body may sometimes be inferred by the history of some such body having been swallowed. The obstructing body can occasionally be felt during palpation. Abdominal distress may exist for days or weeks before obstruction occurs. Vomiting is late and is rarely severe, but pain, tenderness, and distention are marked. In obstruction from gall-stones there will be a record of one or more attacks of hepatic colic. Pain is early and acute, and vomiting is invariable and usually becomes stercoraceous. In obstruction from fecal accumulation chronic obstruction evolves into acute obstruction, pain and vomiting are late or even absent, and the mass of feces can often be felt by rectal examination or by abdominal palpation. In some cases the fluid elements of the feces pass, but the solid elements

agglutinate on the walls of the bowel (the diarrhœa of constipation). Obstruction from strictures or from pressure comes on acutely after a prolonged period of disturbance, during which period occurred attack after attack of temporary obstruction, complete or partial. A history of blood or pus in the stools would indicate tumor of the bowel; a history of blood or pus having been absent would indicate pressure from without (Pepper). In functional obstruction there is no local pain, no tenderness, no tumor, no tendency to collapse, but simply distention and absolute constipation, and possibly non-fecal vomiting occurring in a neurotic or hysterical subject. A phantom tumor due to a local distention of the intestine from limited muscular spasm disappears under ether.

Separation of Intestinal Obstruction from Other Diseases.—Always examine for a strangulated hernia at every hernial outlet. If obstruction is complicated with an irreducible hernia above the seat of lesion, the hernia will always enlarge and become tender because of accumulation of feces (Pepper). Functional obstruction may attend peritonitis or may follow the reduction of a hernia. Appendicitis with peritonitis may cause symptoms similar to those of obstruction, but there is fever, a history of trouble in the right iliac fossa, and the vomiting is not stercoraceous. Pepper says that acute hemorrhagic pancreatitis produces symptoms so nearly identical with those of intestinal obstruction that a diagnosis cannot be made. Poisoning by arsenic or by corrosive sublimate should not be confounded with intestinal obstruction.

Prognosis.—Without surgical interference most cases of acute intestinal obstruction die within ten days, usually within seven days. Death may be due to shock, to exhaustion, to perforation, to peritonitis, or to obstruction of respiration and circulation by tympanites. Recovery occasionally happens by the formation of a fistula externally or

into another portion of the bowel. In acute obstruction from foreign bodies the obstructing body occasionally passes. Volvulus and strangulation by bands are almost invariably fatal unless an operation is performed. In intussusception recovery occasionally follows the sloughing away of the prolapsed gut, but stricture almost inevitably follows this rare event. Functional obstruction gives a good prognosis. The prognosis of chronic obstruction depends upon the causative lesion, and is not nearly so grave as is that of acute obstruction.

Treatment.—In acute obstruction it is usually customary to empty the stomach by lavage and to evacuate the rectum by means of copious injections given while the patient is in the knee-chest position. Hutchinson's method of taxis and massage is uncertain, and is more liable to inflict harm than to confer benefit. Some surgeons apply constant compression to the abdomen by means of straps of adhesive plaster. Puncture of the intestine with an aseptic hypodermatic needle introduced obliquely will relieve gaseous distention. The passage of a small tube from the anus to the sigmoid flexure will empty the colon of gas if no obstruction intervene. In intussusception, give no food by the stomach, give opium and belladonna to stop peristalsis, and distend the bowel below the obstruction with hydrogen gas. Wash out the rectum with copius injections, give an anæsthetic, and insufflate the gas. If this fails, and the condition of the patient is good, perform laparotomy. In obstruction from fecal impaction, use large rectal injections and give small repeated doses of salines or a mixture of castor oil and oil of turpentine. If there are signs of inflammation, do not give cathartics, even in small doses, but give opium and belladonna to arrest vomiting and to relax spasm. Impactions in the rectum can be spooned away. In acute intestinal obstruction, if the symptoms grow worse, do not wait, but open the abdomen

before collapse comes on and find the cause of the obstruction. If it is a gall-stone or enterolith, try to crush it without opening the intestine; if this fails, push it up a little distance, incise the bowel, remove the stone, and close the incision with Lembert sutures. If there be fecal obstruction, break up the masses by pressure and push the fecal plug down. If there be intussusception, reduce the prolapse and shorten the mesentery, but if reduction is impossible perform an anastomosis, or a resection and enterorrhaphy, or make an artificial anus. In volvulus untwist and shorten the mesentery, but if this is impossible treat as an irreducible invagination. In obstruction from adhesions, try to separate them and straighten out the bowel, stitching healthy peritoneum over each raw spot to prevent recurrence. Anastomosis may be necessary. In flexion, separate the intestine, remove the flexion by a V-shaped incision, and suture the wound in the bowel (Senn). In chronic obstruction it is often advisable to perform an exploratory laparotomy and determine by the condition what is to be done. Some tumors external to the bowel are removed. Growths in the bowel-wall may be removed by resection of the involved portion of intestine. Anastomosis may be performed, or an artificial anus may be necessary.

Appendicitis.—Appendicitis, which is an inflammation of the vermiform appendix of the cæcum, is almost invariably the primary lesion of all of those various conditions known as typhlitis, perityphlitis, paratyphlitis, etc.—terms which no longer imply pathological entities, and are in most instances well relegated to obscurity. The appendix is a diverticulum (musculo-membranous in structure) which comes from the posterior and internal part of the head of the colon, and which has no physiological function (in herbivora and rodents it is a functionally active organ). The structure of the appendix is identical with the

structure of the colon. The appendix averages about four and a half inches in length, and its diameter is, as a rule, about equal to that of a No. 9 English bougie; its canal is narrow and is partly closed by the valve of Gerlach (Talamon). The appendix enters the cæcum at its posterior internal part, which part is usually the seat of the most intense pain in inflammation; it is known as "McBurney's point," and corresponds to a point on the surface two inches from the spine, on a line drawn from the umbilicus to the anterior superior iliac spine. The free part of the appendix in one-third of all persons is in relation with the posterior surface of the cæcum; in almost one-third of all persons it is fixed in the iliac fossa, so that if perforation occurs the contents will be voided in the retroperitoneal tissue (iliac abscess). In some cases it is external to the cæcum; in some it passes downward, and in some inward. In about two-thirds of all cases the appendix is completely covered with peritoneum; in one-third of all cases it is in contact, in some part of its length, with cellular tissue (Talamon).

Etiology and Pathology.—Appendicitis is very rare in infants, but is common at any period beyond childhood. Non-traumatic catarrhal or ulcerative inflammation may arise, probably from the action of the bacterium coli commune of Escherich. When non-traumatic inflammation occurs, swelling of the mucous membranes occludes the opening into the colon, and the lumen of the appendix increases and fills up with a thick or muco-purulent fluid. Ulcers sometimes form, which may only involve the mucous membrane, may pass deeply into the coats, or may even perforate. A common cause of appendicitis is the presence of scybala, which are little masses of hardened feces that are at first moist and soft, but soon become dry and hard. They are usually formed in the cæcum, and not in the appendix. This fact is proved by their outline rarely being that of the appendix (Talamon).

These scybala are formed by small portions of feces lodging in depressions found between the longitudinal muscular fibres of the colon, taking the shape of the depressions, and being forced out by peristalsis. Talamon states that a concretion may form in a very large appendix. When a concretion enters the appendix and becomes impacted, the appendix strives to expel it by muscular contraction, and violent symptoms are produced (appendicular colic). Foreign bodies, such as pins, fish-bones, and grape-seeds, may enter the appendix, but they do so far less often than is generally supposed, most alleged grape-seeds from the appendix being only fecal concretions. Appendicitis due to a foreign body, such as a grape-seed or a pin, is known as *traumatic;* appendicitis due to a concretion is known as *stercoral.* A foreign body may produce instant perforation at the site of the body. If impaction of a foreign body or concretion occurs, the orifice of the appendix is closed, the circulation is soon cut off, the secretions are retained, the coats become congested, the diverticulum enlarges enormously, microbes multiply with great rapidity, and the wall of the congested appendix inflames and ulcerates and is finally perforated. Some hold that catarrhal appendicitis can result from extension of a catarrh of the colon and can arise from external traumatism. If before a perforation the appendix adheres to the cellular tissue behind the cæcum, cellulitis or abscess without peritonitis may result. When appendicitis goes on to perforation, there is almost always some peritonitis; but if the steps to perforation are gradual, the peritonitis may be local, and will sometimes by effusion of lymph make a barrier between the appendix and the peritoneal cavity before perforation occurs. When perforation takes place at all suddenly, septic peritonitis is inevitable. Peritonitis can arise without perforation by contiguity of structure or by migration of the bacterium coli commune through the

congested walls of an obstructed appendix. In some cases perforation takes place into the peritoneal cavity, but pus is circumscribed by matting together of the intestines with plastic exudate. The appendix may become gangrenous very rapidly or after some time. In some cases, if the perforation is very small and the appendix is swathed in lymph, or if perforation does not occur, the inflammation may subside. Perforation rarely occurs from liquid pressure or from the pressure of concretion; it is generally due to ulceration or to the action of micro-organisms. Appendicitis which subsides may at any time recur, and the life of the patient is under constant menace. An enormous number of people have had appendicitis. Toft recorded five hundred autopsies, and in thirty-six per cent. of them there were positive signs of past attacks. The disease is often unsuspected in life. These facts prove that the disease may subside without the aid of surgery.

Forms of Appendicitis.—Simple parietal or *catarrhal appendicitis* is not limited to the mucous membrane; hence the term *catarrhal* is not strictly correct. Forty-eight hours after the mucous coat begins to inflame, the peritoneal coat will be involved. In simple appendicitis the diverticulum enlarges, fills up with mucus, and its coats become infiltrated with inflammatory exudate. This inflammation may undergo resolution or suppuration, or may become chronic. In a catarrhal inflammation secondary to catarrh of the colon the case may be chronic from its origin. If inflammation obliterates the lumen of the appendix, the condition is denominated *obliterative appendicitis* (Senn). In appendicitis from a concretion the attack may subside, the fluid elements may be absorbed or flow back into the bowel, and resolution of the exudate may take place, but if the concretion remains in the appendix recurrence is probable. Recurrent appendicitis may be due to inordinate size of the mouth of

the appendix, making of this diverticulum a drag-net for foreign bodies. *Suppurative appendicitis* is due to purulent infiltration of the walls. Pus in the lumen is not purulent appendicitis. *Gangrenous appendicitis* is a moist or septic gangrene, due to interference with the circulation by an impaction near the base and to tissue-destruction by the action of micro-organisms. Perforations occur, and they are often multiple.

Symptoms.—The disease is often ushered in by appendicular colic, which is apt to arise after partaking of an indigestible meal or after indulging in violent exertion. Pain of a colicky nature begins in the right iliac fossa and radiates to the umbilicus; tenderness does not at first exist in the fossa. Nausea and vomiting occur; constipation is usual, but it may alternate with diarrhœa. This condition may pass away or may go on to inflammation. Appendicitis may follow colic or may appear without a preceding colic, and it is manifested by violent abdominal pain which is aggravated by movement, by pressure, and by breathing. This pain is usually intense in the right iliac fossa, but radiates to the umbilicus or even over the entire abdomen. The patient lies upon the right side and draws up the right leg. The abdomen is distended and rigid. Tenderness exists in the right iliac fossa, and the point of greatest tenderness, which is known as "McBurney's point," is apt to be about two inches from the anterior superior spine, on a line drawn from the spine to the umbilicus. Irregular fever arises. The pulse becomes frequent and hard. The respiration is shallow and thoracic. Occasionally a chill occurs. Vomiting is common. Great thirst, anorexia, and obstinate constipation exist. Hiccough is not unusual. The urine is scanty and high colored. The face is anxious and expressive of pain. If the inflammation continues, in from one to two days a swelling may often be detected in the right iliac fossa. This swelling may be small

or large, distinct or obscure; it may be detected by palpation of the abdomen alone or by palpation with a finger in the rectum. If the tenderness is great and the abdomen tense, ether may be required to determine the nature and extent of the swelling. In perforative appendicitis an initial chill may occur, and the pain is very violent; there are fever, coated tongue, vomiting, excessive tenderness, and frequent pulse. Tympanites is the rule, but the belly may be flat, and collapse rapidly arises. If abscess forms, there may be œdema of the skin or even fluctuation. In sudden perforation there is collapse and, if reaction occurs, septic peritonitis. In gangrenous appendicitis there are sepsis and collapse. It is often impossible to distinguish the form of an appendicitis, but remember that sudden pain and local tenderness in the iliac fossa, with fever, mean appendicitis, whether a swelling is found or not.

In a mild case resolution occurs, pain diminishes, the bowels move, fever disappears, and in a week or so the patient feels all right. In more severe cases local peritonitis arises, or suppuration occurs with irregular fever, or perforation takes place, or the appendix becomes gangrenous. Pus may be evacuated into the bowel, into a cavity formed by lymph (appendicular abscess), into the cellular tissue back of the colon, or into the peritoneal cavity. Evacuation of pus into the peritoneal cavity causes collapse and septic peritonitis. Catarrhal appendicitis is apt to be mild, but not of necessity, as it may cause the gravest symptoms. The pains of colic are due to appendicinal contractions attempting to force out a foreign body or imprisoned mucus. The pains of beginning perforation are localized, intense, and accompanied by the tenderness of a local peritonitis.

Treatment.—In appendicular colic a saline is to be given, followed, after a movement occurs, by opium. If tenderness exists, do not give a purgative, because in appendicitis

violent peristalsis may produce perforation. The old theory of fecal impaction in the head of the colon has been exploded by Weir, Bull, Dever, Keen, and others, who have never seen it. In an appendicitis even with slight symptoms many surgeons maintain that an operation should be performed, because slight symptoms are no sign that even in an hour or two gangrene or perforation will not occur. Early operation is comparatively safe; operation after perforation, gangrene, or septic peritonitis arises must be done, but it is usually futile. Other surgeons, in a first attack, if the symptoms are mild, wait and temporize, apply a hot-water bag over the right iliac fossa to favor plastic exudation, and give opium in full doses. Some open the case with salines, apply an ice-bag over McBurney's point, and after a free movement of the bowels give opium and keep the patient on liquid diet. If the symptoms become worse, they recommend operation. In recurrent appendicitis, after the attack passes away, operate. In any severe case, in a case with distinct swelling, and in any case where suppuration, gangrene, or perforation are thought to have occurred or to be liable to occur, operate at once. (See *Operation for Appendicitis.*)

Peritonitis.—In rare instances peritonitis is said to be primary, following a cold; but most surgeons doubt this.

Plastic peritonitis is due to an aseptic cause (traumatism or chemical irritation); it remains limited, and is really a process of repair rather than of inflammation. The *symptoms* of plastic peritonitis are local pain, tenderness, and rigidity. Fever exists, due to the absorption of fibrin-ferment and the products of tissue-change; adhesions form, which may be either temporary or permanent. Recovery is the rule. The *treatment* comprises saline purgatives followed by rest, opiates, a liquid diet, and local heat (hot-water bag or fomentations).

Septic peritonitis is apt to destroy life even before the

peritoneum presents any marked change. Death ensues from the absorption of toxic alkaloids. Septic peritonitis may arise during puerperality, through lymphatic infection; it may be due to infection from without by an operation or an accident, to perforation of an ulcer, to gangrene of a portion of the intestine, to rupture of an abscess into the peritoneal cavity, or to migration of micro-organisms through a damaged wall of the bowel. It is made manifest by a chill, a shock, or rapid collapse, very rapid pulse, temperature which is apt to be subnormal or to soon become so, dry tongue, delirium, persistent vomiting, and often, but not invariably, distention. In puerperal peritonitis or septic peritonitis from operation there is often no pain; in perforative peritonitis there is acute pain. Patients usually die within five or six days. Treatment is rarely successful. The abdomen is opened, flushed out, and drained, and any perforation is closed. Stimulants are strongly pushed. The patient is fed upon liquids (koumiss especially).

In **fibrino-plastic peritonitis** the septic organisms are fewer or less virulent, the products of germ-action are limited and surrounded by adhesions, and *circumscribed* suppurative peritonitis is apt to arise.

Suppurative peritonitis differs clinically from septic peritonitis in the fact that it is more apt to be circumscribed and less apt to be fatal. The causes of both are identical. In septic peritonitis death occurs from absorption of ptomaïnes before obvious pathological changes occur in the peritoneum; in suppurative peritonitis the microbes are fewer, are less virulent, or vital resistance is more decided, and suppuration follows marked changes in the peritoneum. In suppurative appendicitis the pyogenic bacteria are always present, and there exists in the peritoneum a wound or damaged area to constitute a point of least resistance.

Symptoms.—Chilliness or a rigor is common, followed by

fever, the temperature rising to 102° or 104°; pain is intense, and is accentuated by motion and pressure; the attitude of the patient is assumed to relieve pain (he lies upon his back, with the shoulders raised and the thighs drawn up); there are vomiting, obstinate constipation, and distention and rigidity of the abdominal walls. The constipation may be due either to tympanitic distention or to the shock of a perforation inhibiting intestinal peristalsis. In perforation gas often passes into the peritoneal cavity and obscures the liver-dulness; in tympanites without perforation the liver is pushed up and its dulness remains, but on a higher level. Pus unconfined by adhesions will gravitate to the most dependent part of the peritoneal cavity. Circumscribed suppurative peritonitis presents the signs of a deep abscess. In some cases of suppurative peritonitis there is no tympanitic distention or rigidity; in some cases there is no fever, and a subnormal temperature may even exist. The high-tension pulse of peritonitis is due to the tympanitic distention emptying the bowel-walls of blood, and thus increasing the amount of fluid in the other vessels of the body.

Treatment.—In the beginning of ordinary peritonitis without perforation, give a saline cathartic, which will empty the peritoneal cavity of fluid, will favor the elimination of microbes, and will combat inflammation. The old-time remedy was opium, but Tait proved its inefficiency, and showed that it masked the symptoms and often created a false sense of security in the very midst of imminent dangers. The usual method of administering salines is to give ʒj of Rochelle salt and ʒj of Epsom salt every hour until a free movement occurs. This treatment will often cut short a beginning peritonitis. Give an enema of turpentine at the same time as the saline. After the bowels move, give opium for pain. If this treatment fails, open the belly, explore for the causative condition, remedy it, flush, and drain. In *perforative*

peritonitis *do not* give cathartics: they will only increase the extravasation and prevent its limitation by lymph. In perforative peritonitis perform a laparotomy, suture the perforation, flush out the belly, and drain. A circumscribed abscess is to be opened and the primary lesion sought for and, if found, removed. Do not tear up the lymph barriers in an attempt to find the primary lesion; rather let it go undiscovered. Pack iodoform gauze against the intestines to reinforce the barrier of lymph, and insert a tube. Every patient with peritonitis requires stimulants and frequent feeding with liquid food.

Tubercular peritonitis is seen by the surgeon as a primary local tuberculosis, though it occurs also as an associate of phthisis and as a part of a general tuberculosis. Abdominal section with drainage cures not a few cases.

Operations upon the Abdomen: Abdominal Section (Cœliotomy; Laparotomy).—In opening the abdominal cavity for exploratory purposes or to gain access to some area of abdominal or pelvic disease, the patient is carefully prepared as for any operation. The instruments required depend upon the nature of the case. As a rule, there are required scalpels, scissors, a dry dissector, two pairs of dissecting-forceps, hæmostatic forceps, pedicle-forceps, Hagedorn needles, a needle-holder, drainage-tubes, gauze pads, sponges, silk, catgut, silkworm gut, Pacquelin cautery, an electric light, a bag, a tube, and a solution for hypodermoclysis. Always count the instruments, sponges, and pads, and write down the number.

Operation.—In some cases the patient is placed recumbent, in others is put in the position of Trendelenburg (Fig. 145). The patient is placed near the right side of the table, the extremities and the chest are covered with blankets, and sterilized sheets are placed well around the field of operation. The surgeon steadies the skin of the belly with the fingers of his left hand, and, holding the knife in the right

hand, makes an incision about two inches long. This incision is often made in the middle line, but not invariably, and is placed midway between the pubes and umbilicus. The first cut goes to the aponeurosis. Clamp the vessels. Do not hunt for the linea alba below the umbilicus, but go right through or between the recti muscles. Divide the transversalis fascia, beneath which is a little fat, and expose the peritoneum. The latter structure is recognized by its glistening appearance, by the ease with which it can be pinched up between the finger and thumb, and by the readiness with which its opposed surfaces can be made to glide over each other. On identifying the peritoneum, catch it at each side of the incision with forceps, lift it up, nick it with a knife, and open it with scissors to the length of the external wound. To prevent the stripping of the peritoneum, a good plan is to anchor it to the belly-wall with a stitch on each side of the incision. Through the wound thus made the abdomen and its contents are explored, the trouble located, and determination made as to whether or not operation is advisable, and, if it is advisable, what form it shall take. It may be necessary to enlarge the wound. This is done by placing the index and middle fingers of the left hand in the belly, with their pulps against the peritoneum, in the line where the surgeon will cut, to serve as supports to the scissors and as guards to intraperitoneal structures. The scissors are introduced and the wound is enlarged upward around the umbilicus if necessary. As soon as the incision is complete, Treves pushes a large sponge into Douglas's pouch and leaves it there until the operation is completed. Slender adhesions are broken off with the finger or are pushed off with gauze; firm adhesions are tied and cut.

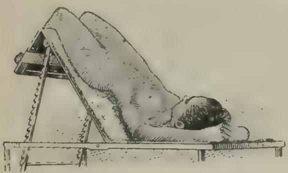


FIG. 146.—The Trendelenburg Position.

The toilet of the peritoneum is important after the operation is completed. Following a clean laparotomy, when but little blood has flowed into the cavity, flushing out is not required; if much blood has flowed or if any septic matter has passed into the peritoneal cavity, after removing the sponge from Douglas's pouch flush out the belly thoroughly with warm boiled water, and sponge out the fluid which will not run out by gravity. Flushing is continued until the fluid runs clear. Before closing the wound, stop hemorrhage and count the instruments and sponges. In most instances drainage is not needed, but it must be used in septic cases and when hemorrhage has been severe. The best tube is the glass drain, which is introduced at the lower angle of the wound and reaches the bottom of the pouch of Douglas. This tube is repeatedly emptied during the progress of the case by means of a syringe. In closing the wound some surgeons close the peritoneum with a continuous catgut suture and close the belly-wall with interrupted sutures of silkworm gut; some operators close with interrupted silkworm-gut sutures, including peritoneum, muscles, and skin in each stitch. Dress with antiseptic gauze and wood-wool, and apply a flannel binder.

In section for *appendicitis*, make a vertical incision two inches in length and two inches internal to the anterior superior spine of the ilium. After opening the peritoneum, find the appendix by the following method: Follow the parietal peritoneum outward with the finger, then backward, then inward; the first obstruction it encounters is the colon. Pass the finger down to the head of the colon, find the appendix, usually posterior and internal, and lift it into the wound. In most cases the neck of the appendix is tied with strong silk, gauze is packed around it to prevent septic matter entering the abdomen, the appendix is cut off, and the stump is cauterized with pure carbolic acid and is inverted into the colon by

Lembert sutures. If there is no abscess, perforation, or gangrene, drainage is unnecessary; otherwise it is necessary. Always irrigate. In opening an abscess following perforation, explore very carefully for the appendix. When it is found, try and lift it up; if this is feasible, remove it. If lifting it up is liable to rupture the barrier of lymph, leave the appendix in place, irrigate gently, pack iodoform gauze around to sustain the barrier, and put a tube deep in the centre. Partially suture the wound. Remove the gauze about the fourth day, but leave the tube some days longer (Barton).

Enterorrhaphy, or **suture of the intestine**, is to be performed with fine silk, a small, round, calyx-eyed needle (Fig. 147) being employed. *Lembert's suture* (Fig. 148, A) is at right angles to the wound. It goes down to, but not through, the mucous membrane. It is formed by picking up a fold of the intestine (one-twelfth to one-eighth of an inch wide) one-eighth of an inch from the edge on one side of the wound, passing the needle through, picking up a fold on the opposite side of the wound, and passing the needle through. On tying the threads the serous membrane is inverted and peritoneum is brought into contact with peritoneum. *Dupuytren's suture* (Fig. 148, B) is a continuous Lembert suture. The *Czerny-Lembert suture* (Fig. 149) is a suture passed through the serous membrane on one side of the wound and brought out in the wound without perforating the mucous membrane. It is re-entered at a corresponding point of the wound-surface of the opposite side, and emerges at a corresponding point of the serous membrane. A Lembert suture is added. *Halstead's suture* includes not only the muscular coat, but also a portion of the tough submucous coat. *Cushing's right-angled suture* (Fig. 148, C) is a continuous suture going through the muscular coat and serving to invert the serous layer. *Jobert's*

FIG. 147.—Eye of the Calyx-eyed Needle.

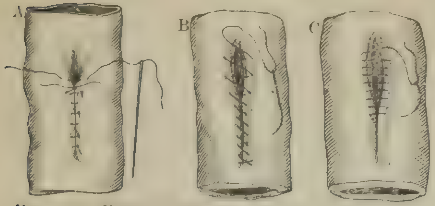


FIG. 148.—Enterorrhaphy: A, Lembert's suture; B, Dupuytren's suture; C, Cushing's suture.

FIG. 152.—Excision of Bowel with Enterorrhaphy and Stitching of the Redundant Mesentery: second step.

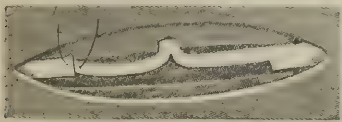


FIG. 149.—Czerny's Method of Tendon-suture.

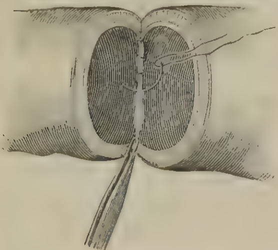


FIG. 150.—Wölfler's Suture.

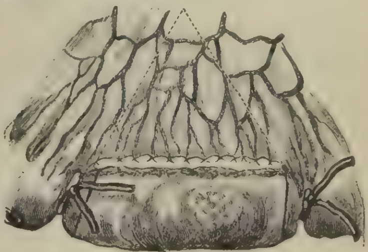


FIG. 153.—Excision of Bowel: first step.

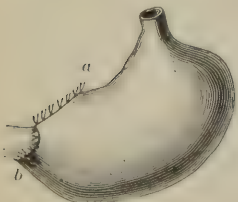


FIG. 151.—Pylorectomy.

FIG. 154.—Gastro-enterostomy (after Wölfler).

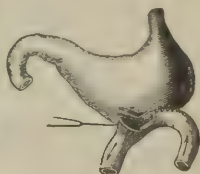


FIG. 155.—Gastro-enterostomy (after Kocher).

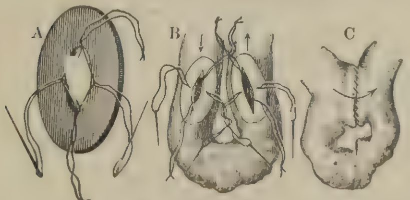


FIG. 156.—Senn's Entero-anastomosis: A, Senn's bone plate; B, intestinal anastomosis; C, operation complete.

FIG. 157.—Inguinal Colostomy (after Maydl).

(*From Esmarch and Kowalzig.*)

suture invaginates serous membrane against serous membrane. Senn modifies this by the use of a ring. *Wölfler's suture* unites the broad layers of the serous coat, the knots being tied internally (Fig. 150). Senn says that after suturing a large wound of the stomach or of intestine a strip of omentum ought to be laid over the wound and fastened by catgut sutures (omental graft). These grafts adhere and are a safeguard against leakage.

Pylorectomy (Excision of the Pylorus).—For one week before any operation upon the stomach, feed the patient upon peptonized milk by the stomach and by nutritive enemata, and during this period wash out the stomach once a day with warm water introduced and withdrawn by a siphon-tube. A few hours before the operation, wash out the stomach again. The best incision through the abdominal wall is transverse over the middle of the tumor. A small incision is made first to permit of exploration, and if the growth is found to be removable, the incision is enlarged. The centre of the incision is over the most prominent part of the tumor, and the direction of the incision corresponds with the long axis of the pylorus. Draw the tumor into the wound, and tuck pads about the stomach and the pylorus to catch extravasated fluids. Free the pylorus; incise between forceps the great omentum near the greater curvature of the stomach, and ligate each end in segments; treat the lesser omentum in the same manner. The greater and the lesser omentum are divided only to an extent sufficient to permit removal of the growth. Repack the gauze pads and tie a rubber tube around the duodenum below the growth. In making the excision remember that the stomach-wound will be much larger than the duodenal wound, and a special method of suturing will be required to approximate the two wounds in size. The lines of incision are shown in Figure 151. The stomach is cut with scissors until two-thirds of

its depth is divided, and the organ is washed out. After stopping hemorrhage this cut is closed by a continuous suture for the mucous membrane and by interrupted Lembert sutures for the serous coat. The remaining portion of the stomach is cut through. The duodenum is cut through its upper half below the growth, and is fastened to the stomach by Lembert sutures at the upper border and Wölfler's sutures at the posterior borders. Wölfler's sutures are applied from inside, pierce all the coats, and bring broad layers of the serous coat into apposition. The remainder of the duodenum is cut through, and its anterior and inferior parts are united to the stomach by a double row of sutures, as set forth above (Fig. 151). Stitch the edges of the cut omenta to the stomach, cleanse the parts, replace the stomach, close the abdominal incision, and dress the wound. Give nothing by the mouth for twenty-four hours. Thirst can be relieved by enemata of water or by the hypodermatic injection of boiled water. After twenty-four hours begin with stomach-feeding, starting with dessertspoonful-doses of peptonized milk every hour.

Gastrostomy.—In Witzel's method an incision is made four inches long, running to the left from the middle line, just below the border of the ribs. After opening the peritoneal cavity seize the stomach, bring it out of the wound, and pack gauze around it. Introduce a rubber tube into the stomach and enfold it by a double row of Lembert sutures. This tube should be five inches long and of the same diameter as a No. 25 French bougie. The opening in the stomach is toward the cardiac extremity, the tube is placed parallel with the belly-wound, and the outer end of the tube emerges in the median line. The stomach is returned, and is stitched by three sutures to the abdominal wall. The tube is retained in place by a catgut stitch through the wall of the tube and the stomach-wall. The

abdominal incision is sutured and a clamp is placed on the tube.

Gastro-enterostomy (Senn's method) is the establishment of a permanent fistula between the stomach and the small intestine, in order to side-track the pylorus. The stomach is irrigated as before pylorectomy. In the operation of gastro-enterostomy a median incision is made through the abdominal wall, from below the xiphoid cartilage to the umbilicus. An opening is made in the stomach, in the direction of the long axis of the viscus, and its edges are stitched with a continuous catgut suture. The contents of the bowel are forced along to below the point where an incision is to be made; a rubber tube is fastened around the bowel above this point, and another below it; an incision is made in the long axis of the bowel, and the margins of the wound are sutured in the same manner as the stomach-wound. Bone plates are introduced into the stomach and intestine, and the ligatures are tied as in intestinal anastomosis (p. 637). Catgut rings or rubber rings may be used. Figure 154 shows the result of a gastro-enterostomy, and Figure 155 shows Kocher's method of gastro-enterostomy without rings.

Enterectomy, or Resection of the Intestine: Enterectomy with Circular Suturing.—After opening the abdomen, isolate the loop of intestine it is intended to resect. Push a rubber tube through the mesentery, close to the bowel, above the seat of operation, and pass a rubber tube through the mesentery below the seat of operation. Empty this segment of bowel by squeezing and stroking, tighten the rubber tubes, and clamp them to keep the bowel empty. Instead of tubes, strips of iodoform gauze may be used to encircle the bowel. The diseased intestine is resected, each incision being carried through a healthy segment. The lumen of each end of the divided gut is irrigated with boiled water. The divided surfaces are approximated by a double row of sutures—a con-

tinuous suture for the mucous membrane, and Lembert's, Dupuytren's, or Cushing's suture for the serous coat. If a redundant fold of mesentery is left, it can be stitched at its raw edge. Many surgeons remove a V-shaped piece of mesentery and tie the mesenteric vessels. The tubes are removed and the wound is cleansed, closed, and dressed. Figure 153 shows the tubes fastened for excision of the bowel, and Figure 152 shows enterorrhaphy with stitching of the redundant mesentery.

If the two segments of bowel are unequal in size, the narrower part of the bowel should be cut obliquely and the larger part should be cut transversely. To meet this complication Billroth devised lateral implantation. Suppose the cæcum has been resected: its lower end is closed by Lembert sutures, an opening is made in the long axis of the periphery of the colon opposite the mesocolon attachment, and the end of the ileum is sutured into this incision.

Senn advises the insertion of an anastomosis-ring in the ileum, the invagination of the colon as the ring is pulled into place, and the firm suturing of the ring. By Senn's method the ileum may be implanted into the end of the colon or into a slit in the wall of a large bowel after the end of the colon has been closed. In some cases, where one portion of bowel is larger than the other, intestinal anastomosis is the preferable method. For a full week after an intestinal resection the patient is fed chiefly by nutrient enemata. During the first twenty-four hours nothing is given by the stomach but bits of ice, and for the next six days but a very little liquid food is allowed to be swallowed.

Intestinal Anastomosis.—*Operation with Rings.*—In this operation a portion of bowel above the obstruction and a loop below the obstruction are brought into the wound. These segments are emptied, and are kept empty by the fastening around them of rubber tubes or of iodoform strips.

Two tubes are needed for each loop of bowel. Pack in gauze pads. Make an incision in one loop, in the long axis of the bowel, on the surface away from the mesentery; permit the contents to escape externally; irrigate this segment with boiled water; and introduce the bone plate of Senn (Fig. 156, A) or Abbé's catgut ring. A calyx-eyed needle is used (Fig. 147), and the threads of the ring are carried through the coats of the bowel and are gathered together in the bite of a pair of forceps. The other loop of intestine is treated in a similar manner. The intestines are so brought together that the two wounds are opposite each other, the posterior sutures being first tied, next the upper, next the lower, and finally the anterior threads. The ends of the threads are cut off and the entire anastomosis is surrounded by a layer of Lembert sutures or is encircled by Cushing's suture. Figure 156, B, shows an intestinal anastomosis partly finished, and Figure 156, C, shows an anastomosis complete. Figure 158 shows the passing of the sutures when the catgut ring of Abbé is employed.

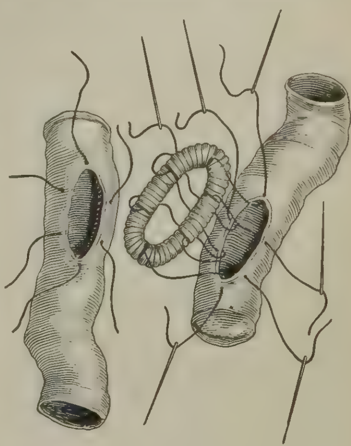


FIG. 158.—Method of Passing the Silk Sutures in Inserting the Rings of Abbé.

Many surgeons are returning to anastomosis without rings in cases of resection. Abbé's method is as follows: After closing the ends he places them side by side and applies two rows of a Dupuytren suture, one-quarter of an inch apart. These rows of sutures are an inch longer than the slit in the bowel will be (Fig. 159), the thread at the end of each row being left long. An incision is made in the bowel, one-

quarter of an inch from the sutures, both rows of threads being on the same side of the cut. This incision is four inches long. The other portion of bowel is then incised in the same way. The adjacent cut-edges are united by a whip-stitch which goes through all the coats, and the free cut-edges are stitched in the same manner (Fig. 160). The surgeon now utilizes the long threads of the first sutures, and brings the serous surfaces of the opposite sides together by means of Dupuytren's suture.

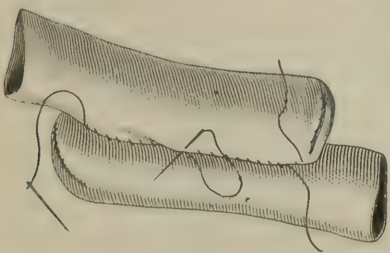


FIG. 159.—Suturing Intestines in Apposition before Incision (Abbé).

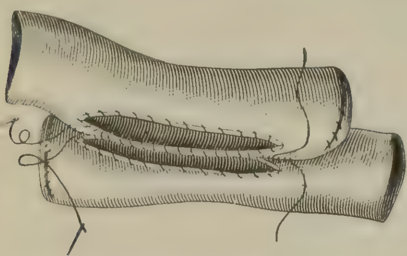


FIG. 160.—Showing the Four-inch Incision and the Sewing of the Edges (Abbé).

Murphy's button is a mechanical arrangement by which an anastomosis is rapidly performed, the two segments being clamped together. For anastomosis below the ileocæcal valve a large Murphy button does admirably, but for anastomosis higher up so small a button must be used that the result is unsatisfactory.

Inguinal Colostomy.—*Maydl's Operation.*—In this operation a vertical incision four inches long is made over the portion of colon to be incised. The colon usually bulges into the wound, but if it does not it may easily be found by following with the finger the parietal peritoneum outward, backward, and inward, the first obstruction it encounters being the mesocolon. Draw the colon out of the wound until its

mesenteric attachment is level with the abdominal incision. Push a glass bar through a slit in the mesocolon near the bowel, and wrap the ends of the bar with iodoform gauze to prevent slipping. The two parts of the flexure are stitched together by sutures which penetrate the serous and muscular coats (Fig. 157). If the colon has to be opened immediately, stitch the serous coat of the bowel to the parietal peritoneum before opening. Whenever possible, wait from twelve to twenty-four hours before opening. The colon is opened by the cautery or by scissors. If the artificial anus is to be permanent, make a transverse incision three-quarters of the way through the bowel. The bar is withdrawn in a few days, and the bowel retracts. If the artificial anus is to be temporary, the incision is longitudinal. This operation has great advantages: it is quick, certain, reasonably safe, and entirely prevents fecal accumulation below the opening. The old operation of lumbar colostomy is now rarely performed. Some surgeons cut one-fourth way through the colon when it is first opened, and entirely across in two or three weeks.

Abdominal Hernia or Rupture.—This condition is the protrusion of a viscus or part of a viscus from the abdominal cavity. MacCormac says the term implies that the protruded viscus is covered with integument; hence a protrusion of viscera through a wound does not constitute a hernia. A hernia has three parts—the sac, the sac-contents, and the sac-coverings. The *sac* is formed of peritoneum. A congenital sac is due to developmental defect, and is found only in the inguinal region or in the umbilicus. An acquired sac is due to intra-abdominal pressure bulging the peritoneal covering of the internal abdominal ring and converting it into a pouch. The sac comprises a body, a neck, and a mouth. A sac once formed is almost certain to persist, because it adheres by its outer surface to surrounding parts,

and hence the sac of a hernia is irreducible even when the contents are reducible. The neck of the sac is due to the constriction through which the sac passes; it becomes furrowed and folded, and the adhesion of these folds causes thickening and rigidity. Hernia of the bladder or of the cæcum has no sac or but a partial sac. The *contents of the sac* depend chiefly on the situation, a portion of the ileum being the usual contents. The colon, the stomach, the great omentum, and other structures may enter the hernial sac. An *enterocele* contains only intestine; an *epiplocele* contains only omentum; an *entero-epiplocele* contains both omentum and intestine; a *cystocele* contains a portion of the bladder. The *coverings of the sac*, which vary with its situation, will be set forth during the consideration of special herniæ. In old herniæ the layers are never distinct, fat and muscle waste, tissues adhere, and the skin stretches and atrophies.

Causes of Hernia.—The male sex is more liable to hernia. It occurs at all periods of life, and hereditary predisposition sometimes seems to exist. Excessive length of the mesentery has been assigned as a cause. Any laborious occupation predisposes to rupture. Any condition which weakens the abdominal wall predisposes (muscular relaxation from ill-health, relaxation of abdominal walls following the termination of pregnancy, the removal of a large tumor, or the tapping of an ascites, and wounds or abscesses of the abdominal wall). The exciting cause is muscular effort (straining at stool, coughing, lifting weights, jumping, straining to make water, and the sexual act). All congenital herniæ are due to structural defects. Hernia is divided clinically into *reducible*, *irreducible*, *incarcerated*, *inflamed*, and *strangulated*.

Reducible Hernia.—In this form of hernia the contents of the sac can be reduced into the abdominal cavity. At a known hernial opening the patient has a smooth enlargement (narrower above than below) which began to grow from

above and extended downward. A distinct neck can often be felt. In enterocele, straining, lifting, or standing enlarges the mass; the tumor becomes smaller and may disappear on lying down; cough causes impulse or succussion; the tumor is elastic, and on reduction there is a gurgling sound. In epiplocele the mass is often irregular and compressible, and feels boggy rather than elastic; muscular effort does not have much influence in enlarging it; impulse on coughing is slight; percussion gives a dull note, and reduction produces no gurgling sound. In entero-epiplocele some parts of the tumor are smooth, elastic, and tympanitic, others are dull on percussion, irregular, and flabby; but the diagnosis of this especial form is uncertain. The victims of reducible hernia complain of some pain on exertion, of dyspepsia, and often of constipation.

Treatment of Reducible Hernia: Palliative Treatment.—Prevent constipation, forbid sudden strains and violent exercise, and order a truss. The continued employment of a truss, especially in young persons, may bring about a cure. The day truss should be applied before rising in the morning and be removed after lying down at night, when a light truss should be substituted. A special truss is applied for bathing. In very fat people there is always trouble in adjusting a truss. A femoral hernia is more difficult to keep reduced than an inguinal hernia. In those cases in which the gut is replaceable, but a portion of omentum is irreducible, it is difficult to maintain reduction with a truss. In an oblique inguinal hernia the pad of the truss fits over the internal abdominal ring; in a direct inguinal hernia, over the external abdominal ring; in a femoral hernia, over the femoral ring at the level of Gimbernat's ligament. MacCormac's rule to measure for a truss is as follows: In either inguinal or femoral hernia, start the tape from the *lower part* of the hernial opening, carry it up to the anterior

superior iliac spine of the same side, then take it around the body, one inch below the crest of the ilium, to the other anterior superior iliac spine, and then to the upper part of the hernial opening."[1] A well-fitting truss will keep up the hernia even when the patient sits in a position to relax the abdominal walls and then coughs and strains. A truss is always uncomfortable at first, but a person soon grows used to it. It should be kept scrupulously clean, and it is well to dust borated-talc powder upon the skin under the pad at least once a day. A truss which does not keep up the hernia or which causes pain does harm. Too strong a spring tends to enlarge the hernial orifice, and thus aggravates the case. Bryant insists that even after an apparent cure with a truss the instrument must be worn for a long time.

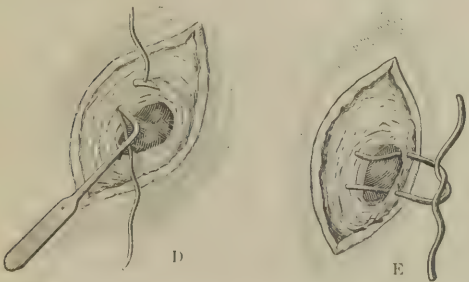
Radical treatment seeks to permanently cure by plugging the mouth of the sac or by obliterating the canal of descent. Radical operations should be performed when strangulation is operated for, in ordinary cases of reducible hernia in which a truss is very painful or does not keep up the bowel, in most cases of irreducible hernia, and in any case which has occasional attacks of obstruction. Radical cures fail if the subject is under three years of age.

Macewen's Operation for Inguinal Hernia.—The instruments required in this operation are scalpels, a blunt straight bistoury, a dry dissector, a grooved director, scissors, a hernia-director, hernia-needles (Fig. 164), dissecting-forceps, toothed forceps, hæmostatic forceps, an aneurysm-needle, blunt hooks, half-curved needles, needle-holder, and catgut sutures. The patient lies recumbent, the thigh being abducted and partly flexed and resting on a pillow beneath the knee. The bowel is reduced, and an incision three inches long is made in the direction of the inguinal canal, the centre of the incision corresponding to the external ring.

[1] Treves's *Manual of Surgery*, "Hernia."

The sac is freed from its attachments below and is lifted up. The surgeon introduces a finger into the inguinal canal and separates the sac from the cord and from the walls of the canal, and then carries the finger through the internal ring and separates the peritoneum for one inch about the periphery of this aperture (Fig. 161, A). A catgut stitch is fastened to the lowest portion of the sac, and is passed through the sac several times, so that pulling on the stitch will purse up the sac (Fig. 161, B). The free end of this stitch is carried through the internal ring into the belly, and is pushed out through abdominal muscles one inch above the internal ring, the skin being pushed aside so as to escape perforation by the needle. The thread is tightened so as to fold up the sac and pull it into the belly. This plugs the ring (Fig. 161, C, D). The thread is handed to an assistant to keep tight until the sutures are introduced into the ring, when the sac is permanently anchored by taking several stitches in the external oblique muscle. A strong catgut suture is passed with a Macewen needle through the conjoined tendon from below upward, the ends of this suture being carried through Poupart's ligament and the outer borders of the internal ring from within outward. This suture is tightened and closes the internal ring. The external ring is sutured and the skin is stitched together (Fig. 161, E).

In congenital hernia the sac is divided in its middle and the lower part is closed by stitches, forming a tunica vaginalis. The upper part of the sac is slit posteriorly to permit the escape of the cord, and is closed by stitches. The operation is finished as in the acquired form (Fig. 162). After this operation the patient should stay in bed for six or seven weeks, and must not walk for eight or nine weeks. Workmen after this operation should always wear a pad and a spica bandage. Children require no pad. Never apply a truss, as strong pressure will atrophy the curative scar.



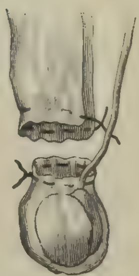


FIG. 161, A–E.—Macewen's Operation for the Radical Cure of Inguinal Hernia: A, Stripping of the sac; B, Purse-string suture; C, Fastening the purse-string suture; D, Passing, and E, tying, the sutures for the internal ring.

FIG. 162.—Macewen's Operation for the Radical Cure of Congenital Hernia.

FIG. 163.—Herniotomy in Inguinal Hernia.

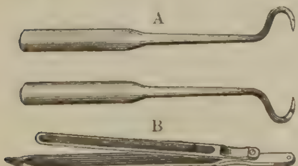


FIG. 164.—A, Hernia-needles; B, Hinged Hernia-director.

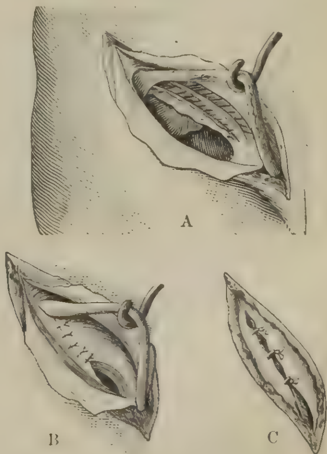


FIG. 165, A–C.—Bassini's Operation for the Cure of Inguinal Hernia.

(*From Esmarch and Kowalzig.*)

Bassini's Operation for Inguinal Hernia.—This operation forms a new inguinal canal. The instruments employed are the same as for Macewen's operation, excepting special needles, which are not needed. The position is the same as in Macewen's operation. An incision is made from the external ring to a point external to the internal ring. The sac is exposed and twisted, its neck is ligated, and it is cut off in front of the ligature. The spermatic cord is lifted (Fig. 165, A); the border of the rectus muscle, the edges of the internal oblique and the transversalis muscles, and the transversalis fascia, are sutured to Poupart's ligament below the cord (Fig. 165, B). The border of the external oblique is sutured to Poupart's ligament above the cord (Fig. 165, C). The skin is sutured. Halstead makes a new inguinal canal and a new ring, and places the cord between the external oblique muscle and the integument in preference to placing it, as does Bassini, below the external oblique.

Radical Cure of Umbilical Hernia.—Cut out the umbilicus (omphalectomy) and approximate the edges.

Radical Cure of Femoral Hernia.—Salzer stitches Poupart's ligament to the pectineal fascia. Cheyne ligates the neck of the sac, stitches the stump to the abdominal wall, dissects out a flap from the pectineus muscle, stitches this flap to Poupart's ligament and to the abdominal wall, and thus fills up the crural canal. Bassini makes an incision parallel with Poupart's ligament, ties the neck of the sac, cuts below the ligature, and returns the stump into the belly. He attaches by deep sutures Poupart's ligament to the pectineal aponeurosis as high up as the pectineal eminence, the cord or round ligament being drawn out of the way. Superficial sutures are passed between the pubic portion and the iliac portion of the fascia lata.

Irreducible Hernia.—The tumor in irreducible rupture presents the usual evidences of hernia, shows an impulse on

coughing, but cannot be replaced in the abdomen. Sometimes a portion is reducible and a portion is irreducible. A hernia may become irreducible because of the size of the mass, because of adhesions, or because of a great growth of omental fat. An irreducible hernia is liable to be bruised and to cause much distress and pain, and is always a menace to life because of the danger of obstruction and strangulation. A small irreducible hernia can be supported by a hollow padded truss; a large hernia of this variety is carried in a bag-truss. The patient must not take very active exercise, must keep the bowels regular, and must live upon a plain diet. Most of these cases should be treated by operation.

Incarcerated or Obstructed Hernia.—Obstruction takes place by the damming up of feces or of undigested food, the fecal current being arrested, but the blood-current in the walls of the bowel being undisturbed. Incarceration is commonest in irreducible hernia, umbilical hernia, and during the existence of constipation. The tumor enlarges and becomes tender, painful, and dull on percussion; pressure diminishes it in size; it is irreducible, but still presents impulse on coughing. The abdomen is somewhat distended and painful; there are nausea, constipation, and not unusually slight vomiting. Constitutional disturbance is slight and constipation is not absolute, wind at least usually passing. Vomiting is not fecal. The *treatment* is rest in bed in a position to relax the belly, an ice-bag over the hernia, and a little opium for pain. Do not give a particle of food for twenty-four hours; when the active symptoms subside give an enema, and after this acts a dose of castor oil. Do not employ taxis, as bruising the bowel may produce strangulation.

Inflamed Hernia.—Inflammation of a hernia is local peritonitis due to injury of an irreducible hernia. The mass

becomes tender, painful, and hot. In enterocele much fluid forms; in epiplocele the mass becomes hard. The hernia cannot be reduced; there is constipation, often vomiting, usually fever, but the mass still shows impulse on coughing. Vomiting is not fecal. Some wind is usually passed by the bowels. Constitutional symptoms are slight. The *treatment* is rest in bed with abdominal relaxation, an ice-bag to the tumor, a small amount of opium by the mouth if pain is severe, an enema, and when this acts a saline. If pus forms, incise and drain.

Strangulated hernia is a condition in which not only is the fecal circulation arrested, but the circulation of blood in the bowel-wall is also arrested. The bowel is irreducible and obstructed, and the blood ceases to circulate. Strangulation is commonest in old inguinal ruptures in active, middle-aged men, and is more frequent in enteroceles than in epiploceles. It may be due to entry into the sac of more intestine or omentum, which has been forced down by sudden movement or violent effort. It may be due to active peristalsis or to congestion, and it may arise from inflammation or from incarceration. The constriction is usually at the neck of the sac, in the outside tissues, or even in the sac itself. In an hour-glass hernia the constriction is in the body of the sac. Adhesions within the sac may cause strangulation. Spasmodic contraction of the tissues about the neck of the sac is an exploded hypothesis. When strangulation once begins the hernia swells, a furrow forms at the seat of constriction, the bowel and omentum below the constriction become deeply congested and œdematous, and, finally, the rupture passes into a state of moist gangrene. The sac is apt to inflame, and inflammation produces fluid and lymph; serum accumulates in the sac, being first clear, then bloody, and finally brown and foul. When gangrene is once established the bowel is in danger of rupturing. A strangulated femoral hernia

becomes gangrenous more rapidly than does a strangulated inguinal hernia.

Symptoms.—The hernia is found to be irreducible; it becomes larger, tender, painful, and dull on percussion, and gives no impulse on coughing. Abdominal pains, uncontrollable vomiting, and prostration come on. The vomiting is first of the contents of the stomach, next of bilious matter, but finally of feces. Constipation is absolute, no wind even being passed, though in the very beginning there may be some diarrhœal passages from below the constriction. The urine is scanty and high-colored, and contains only a small amount of the chlorides; the tongue becomes dry and brown; the thirst is torturing; the pulse is small and very rapid. Pains in the abdomen and in the hernia become violent, and collapse rapidly develops. When gangrene begins, the symptoms apparently lessen in violence: there is a "delusive calm." Vomiting usually ceases, though regurgitation may take its place; hiccough begins; the pain abates or disappears; the pulse becomes very feeble and intermittent; collapse deepens, and delirium is usual. It is a safe clinical rule that in strangulated hernia cessation of pain without the relief of constriction or the use of opiates means that gangrene has begun. In a pure omental hernia strangulation produces similar but less decided symptoms. In Littré's hernia only a portion of the circumference of the bowel is constricted, usually in the femoral ring. In a strangulated Littré hernia constipation is rarely absolute and the tumor is often undiscovered.

Treatment.—In treating strangulated hernia, place the patient upon his back, bend the knees over a pillow, and rigidly interdict the administration of food. An attempt is to be made to effect reduction by gentle manipulation or taxis. In applying taxis to a femoral or inguinal hernia, flex and adduct the thigh of the affected side. In applying taxis

to an umbilical hernia both thighs should be flexed upon the abdomen. Always lower the shoulders and head and raise the pelvis, and accomplish this by lifting the foot of the bed and placing pillows under the pelvis. Grasp the neck of the sac with the fingers and thumb of one hand, and employ the other hand to squeeze the hernia and urge it toward the belly. In direct inguinal hernia the pressure should be backward and a little upward; in umbilical hernia it should be backward; in oblique inguinal hernia it should be upward, outward, and backward; in femoral hernia it should be downward until the hernia enters the saphenous opening, and then "backward toward the pubic spine" (Sir Wm. MacCormac). If the bowel is reduced, it passes from the hand with a sudden slip and enters the belly with an audible gurgle; omentum, when reduced slowly, glides back without gurgling. Taxis is never to be continued long, and it is not even to be attempted in cases of great acuteness, in cases where strangulation has lasted for several days, in cases known to have previously been irreducible, in cases associated with stercoraceous vomiting, or in an inflamed or gangrenous hernia.

If taxis fails, obtain the patient's permission to operate. Anæsthetize; try taxis again while ether is being dropped upon the hernia to cause cold; if it fails, at once perform herniotomy. Taxis possesses certain dangers: it may rupture the bowel; it may rupture the neck of the sac and force the bowel through the rent; it may strip the peritoneum from around the hernial orifice and force the bowel between the detached peritoneum and the abdominal wall; it may reduce a hernia into the belly when the bowel is still strangulated by adhesions; it may reduce the hernia *en masse* or *en bloc*, the sac and strictured bowel being forced together into the abdomen. By reduction *en bissac* is meant the forcing of a congenital hernia into a congenital

pouch or diverticulum. In any of the above accidents strangulation may persist after apparent reduction by taxis, and this condition calls for instant laparotomy—in most instances through the hernial aperture. If taxis is successful, put the patient to bed, apply a pad and bandage, allow the patient to take no food until vomiting ceases, merely permitting him to suck bits of ice, keep him on a liquid diet for several days, and stop peristalsis by opium. At the end of the first week give solid food; if the bowels have not acted by this time, administer an enema, following it by a dose of Epsom salt if there is no pain or no disposition to vomit. Some surgeons advocate inversion as a valuable aid to taxis.

Herniotomy.—The instruments required in herniotomy are a scalpel, a hernia-knife and director, hæmostatic and dissecting forceps, blunt hooks, scissors, a dry dissector, partly-curved needles, and a needle-holder. Drainage-tubes should be ready. In the *operation* the patient lies upon his back with the shoulders raised, the surgeon standing upon the patient's right side. In *oblique inguinal hernia* a fold of skin is raised at right angles to the axis of the external ring and is transfixed, and the wound which results is extended until it becomes three inches in length. The tissues are divided until the sac is reached, and no attempt is made to specially identify them. The sac is known by the fat which usually covers it, by the arborescent arrangement of its vessels, by the fact that it can be pinched up between the finger and thumb and the layers rolled over each other, and by the fluid within the sac. Should the sac be opened? In very recent cases it is usually unnecessary, but if there is any doubt as to the condition of the bowel, or if a radical cure is to be attempted, open the sac and be certain as to the condition of its contents. The general rule should be to open the sac. The sac is opened and the contents examined for fecal odor (which is not unusual) and for gangrenous smell; the

thickness of the bowel is estimated, and the color and lustre are determined. Always pull down the bowel and examine the seat of constriction. If the bowel is healthy, restore it and do a radical cure. If there is a gangrenous or a strongly fecal smell, wash the sac and bowel with corrosive-sublimate solution and fasten the bowel to the skin by a couple of stitches. In oblique inguinal hernia nick the constriction upward and outward, as shown in Figure 163. In direct inguinal hernia the cut is made upward and inward. Do not open the bowel at this time, but dust the parts with iodoform and dress. The bowel may recover in a day or two, when it can be restored to the belly; or it may slough and form an artificial anus. If gangrene of the bowel is pronounced, resect the gangrenous bowel, and either make an artificial anus or perform an end-to-end approximation or an anastomosis. Gangrenous omentum requires ligation and resection. If the bowel is fit to reduce, push it just inside the ring, irrigate the parts, insert a drain, and stitch. In many cases perform a radical cure. In *femoral hernia*, make the incision one inch internal to, and parallel with, the femoral vessels, and crossing the tumor and ligament (Barker). Divide the constriction by cutting upward and a little inward. In *umbilical hernia* make a slightly curved incision a little to one side of the middle of the tumor, open the sac, separate adhesions, and divide the constriction by cutting upward or downward, and sometimes also laterally.

After an operation for strangulated hernia, put the patient to bed; bend the knees over a pillow; give no food by the mouth for thirty-six hours (MacCormac), only allowing the patient bits of ice to suck; give nutrient enemata containing brandy; and use morphia hypodermatically. If the bowels have not acted by the end of the first week, give an enema and follow this by a saline. Remove the drainage-tube on the third day. At the end of about three weeks, if a radical

cure has not been attempted, get the patient up, first applying a pad and a spica of the groin. A truss cannot be worn for five or six weeks.

Anatomical Varieties of Hernia.—In *direct inguinal hernia* the bowel passes out through Hesselbach's triangle internal to the deep epigastric artery. It enters the inguinal canal low down, and passes outside the conjoined tendon or forces the conjoined tendon before it or splits through the tendon. The neck of the sac is internal to the deep epigastric artery. The coverings of this hernia when it passes external to the conjoined tendon are the same as for indirect inguinal hernia; when a direct hernia pushes before it the conjoined tendon, its coverings are skin, superficial fascia, intercolumnar fascia, conjoined tendon, transversalis fascia, subserous tissue, and peritoneum. In *indirect inguinal hernia* the bowel passes through the internal abdominal ring external to Hesselbach's triangle and external to the deep epigastric artery. It passes down the inguinal canal and emerges from the external ring; it may enter the scrotum or labium (scrotal or labial hernia), or it may not. The neck of the sac is external to the deep epigastric artery. Its coverings are—skin, superficial fascia, intercolumnar fascia, cremaster muscle, infundibuliform fascia, subserous tissue, and peritoneum. *Congenital* or *encysted inguinal hernia* is a hernia into an unclosed vaginal process. The bowel in congenital hernia has one layer of peritoneum in front of it. The testicle is posterior. In *funicular hernia* the vaginal process is closed below and open above, and a hernia takes place into the unclosed funicular process. The bowel has one layer of peritoneum in front of it. The testicle is posterior. In *infantile hernia* the vaginal process is occluded above, and not below, and the septum of occlusion is pushed down by the hernia. In infantile hernia the bowel has three layers of peritoneum in front of it. The testicle is in front. Always remember

that congenital hernia may not appear for several months after birth. Congenital hernia conceals or buries the testicle; acquired hernia does not. In *femoral hernia* the bowel descends along the femoral canal, and the neck of the sac is at the femoral ring. A femoral rupture is always external to the pubic spine; an inguinal rupture is always internal to the pubic spine. Femoral hernia is never congenital. Its coverings are—skin, superficial fascia, cribriform fascia, crural sheath, septum crurale, subserous tissue, and peritoneum. *Umbilical hernia* may be congenital (the ventral plates having closed incompletely), infantile (the cicatrix of the umbilicus having stretched), or acquired. *Ventral hernia* is a protrusion at any part of the anterior abdominal wall except at the umbilicus. *Obturator hernia* passes through the obturator membrane or the obturator canal, and is felt below the horizontal ramus of the pubes, internal to the femoral vessels. *Lumbar hernia* occurs at the edge of, or through, the quadratus lumborum muscle. *Sciatic hernia* passes through the great sacro-sciatic foramen. In *diaphragmatic hernia* some viscera of the abdomen pass through a natural or an accidental opening into the thorax. *Pudendal hernia* protrudes into the lower part of the labium. *Perineal hernia* presents in the perineum, between the rectum and the prostate gland or between the rectum and the vagina. *Hernia into the foramen of Winslow* is very rare.

XXVII. DISEASES AND INJURIES OF THE RECTUM AND ANUS.

Hemorrhoids, or Piles.—There are three varieties of varicose tumors of the rectum, namely: *internal*, which take origin within the external sphincter; *external*, which take origin without the external sphincter; and *mixed* hemorrhoids, which are a combination of the two.

External Hemorrhoids.—A livid, soft enlargement appears near the edge of the anus, due to rupture of a distended vein, and accompanied by decided pain and other evidences of inflammation. These blood-tumors may get well if let alone, or they may suppurate. External piles are covered with skin, are apt to be multiple, and cause no pain except when inflamed. When the superfluous tags of skin around the anus enlarge, they give rise to much pain and inflammation. These cutaneous outgrowths are often spoken of as a form of external piles.

Symptoms and Treatment.—An inflammatory enlargement is detected, which enlargement is tender and painful. Pain is increased by defecation. These piles do not bleed. In treating external hemorrhoids some surgeons merely use remedies to combat the inflammation. An old plan of treatment is to incise the blood-tumor, turn out the clot, and pack with a bit of iodoform gauze. Matthews freezes the part or injects cocaine, catches up the blood-tumor with a volsellum, excises the tumor and the tabs of inflamed skin, dusts the part with iodoform, and dresses it with antiseptic gauze. The bowels should be tied up for two days. Never inject external piles with carbolic acid: it causes great inflammation, excessive pain, and is not free from danger. If the patient declines operation, order rest, a non-stimulating diet, avoidance of tobacco (Matthews), a saline purgative, injections into the rectum of cold water several times a day, sponging of the anus frequently with hot water, and the application of hot poultices. As the acute symptoms begin to disappear use lead-water and laudanum; when they have nearly subsided, apply zinc ointment. Extract of hamamelis is a valuable application to external piles.

Internal hemorrhoids are internal to the external sphincter, just within the anus, and they prolapse easily. They are covered by mucous membrane. *Capillary* piles are

small, sessile, with a surface like a mulberry, and bleed freely. Children are, as a rule, not very liable to develop piles, but they not infrequently have this capillary form. *Venous* piles are the ones commonly met with. They extend from just above the anal margin of the rectum for an inch or more. They are purple in color, soft, irregular in outline, and are usually multiple. They bleed, but not so easily as the capillary pile, when irritated by hard fecal masses. Each pile is composed of a varicose vein, some little fibrous tissue, and a few arterial twigs. *Arterial* piles are very unusual. They are large, smooth, pedunculated, and bleed easily and freely. Each pile contains, besides a distended vein, arteries of some size.

Anything producing venous congestion in the rectum—constipation, diseases of the rectum, enlargement of the prostate, pregnancy, tumors of the womb, congestion of the liver, cirrhosis of the liver, certain diseases of the heart and lungs, sedentary occupations, relaxing climate, and stricture of the urethra—will cause hemorrhoids.

Symptoms and Treatment.—If there is no bleeding and no protrusion, the piles give no trouble. The first symptom is usually hemorrhage, and rectal examination by the speculum will make clear the condition. After a time, during defecation, the piles protrude; they may reduce themselves when the patient stands up, or it may be necessary to push them in. Pain does not exist in uncomplicated cases, and pain during or after protrusion means "abrasion, fissure, or ulceration" (Matthews). *Palliative treatment* will not cure, but it will give great comfort. Some people only suffer at rare times when the liver is congested, and such subjects will not submit to operation. Remove, if possible, the cause (alcohol, irritating foods, want of exercise, etc.); restrict the diet; insist on regular exercise; give a course of Carlsbad salt, and follow this by the stomach use of bichloride of mercury

(gr. $\frac{1}{20}$ after each meal). Prevent constipation by a nightly dose of fluid extract of cascara sagrada. After each movement wash off the parts and syringe out the rectum with cold water, and dry with a soft rag. If the hemorrhoids prolapse, after restoring them and injecting water, insert a suppository containing gr. v of the extract of hamamelis, and use another suppository at bed-time. When the piles prolapse and inflame, rub Allingham's ointment on the parts (ʒij each of ext. of conium and ext. of hyoscyamus, ʒj of ext. of belladonna, and ℥j of cosmoline). Matthews uses gr. xij of cocaine, ʒj of iodoform, ʒss of ext. of opium, ℥j of cosmoline. If the piles are protruding and reduction cannot be effected, put the patient to bed, give a hypodermatic injection of morphia, and apply hot poultices. If reduction cannot soon be effected, operate.

Operative Treatment.—Give a saline the morning before, and an enema the evening before, the operation, and wash out the rectum well the morning of the operation. In treating by *injection of carbolic acid* the tumors are drawn out or the patient strains them out, an injection is given by a hypodermatic syringe into the centre of the pile, and as each pile is injected it is pushed into the rectum. The dose for each pile is 10 drops of a solution containing 3 parts of glycerin, 3 of water, and 1 of pure carbolic acid. The injection is rarely curative, is very painful, and may produce hemorrhage, phlebitis, pyæmia, stricture, and even death (W. T. Bull). The *clamp and cautery* are used in interno-external piles. The pile is caught with forceps and drawn outside. Smith's clamp is applied with the ivory surface against the mucous membrane of the bowel, the pile is cut off, and the stump is seared with the Pacquelin cautery at a dull-red heat. *Excision* is preferred by Allingham. He stretches the sphincter, holds it open with a retractor, catches up the pile, cuts it off, and twists the bleeding vessels. Some prefer to pass

a ligature, cut off the tumor, and tie the thread (Fig. 166). *Whitehead's operation* is suited to severe cases, and only a surgeon who can master violent hemorrhage should venture to perform it. The entire pile-bearing area of mucous membrane is dissected out, and the cut margin of mucous membrane is pulled down and stitched to the surface. The sphincter must be dilated as a preliminary.

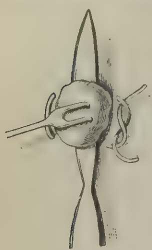


Fig. 166.—Extirpation of Hemorrhoids (Esmarch and Kowalzig).

The ligature is the easiest and most generally useful method. In this operation stretch the sphincter and treat each hæmorrhoid separately. Catch a pile with a pair of forceps or a volsellum, pull it down, and cut a gutter through the skin-margin; tie the small piles without transfixing (transfix the large piles); tie with silk (coarse silk for the large piles, finer silk for the small piles); cut off the tumor, and cut the ligatures short. Treat the other piles in the same manner. Irrigate with corrosive-sublimate solution, dust with iodoform, pack a piece of iodoform gauze into the rectum, and apply a gauze pad and a T-bandage. Give some morphia to lock up the bowels, and keep the patient on a light diet for three days, at the end of which time a saline may be given. Just before the bowels act remove the dressings and give an enema of warm water. After the movement wash out the rectum with 1:5000 corrosive-sublimate solution and apply a gauze pad over the anus. Irrigate daily until healing is complete. After the tenth day examine with a speculum to see that the ligatures have come away; if any are found in place, remove them.

Prolapse of Rectum.—If the mucous membrane alone is prolapsed, the condition is called "prolapsus ani;" if the entire thickness of the rectal wall is prolapsed, it is called "prolapsus recti." Prolapse, which is apt to occur from

excessive straining at stool, is commonest in feeble, ill-nourished children. Piles and worms may be complicated with prolapse. Straining from phimosis, stone in the bladder, or stricture may be causative. Prolapse may be either large or small, but it tends to recur again and again, and eventually the mucous membrane inflames, ulcerates, or sloughs. Strangulation of the prolapsed part may occur.

Treatment.—In *palliative* treatment the patient must not strain at stool; if prolapse occurs, the parts are bathed in cold water and restored. Constipation must be prevented (enemata of water or glycerin may be used). If a prolapse is caught firmly, place the patient upon his knees and chest, wash the mass with cold water, grease it with cosmoline, insert a finger into the rectum, and apply taxis around the finger (Matthews). If this fails, cover a finger with a handkerchief and insert the wrapped digit into the rectum; if this prove futile, invert the patient. Severe cases require ether. After reduction apply a compress, direct it to be worn except when at stool, and before each act of defecation give an injection of cold water containing an astringent (tannin or fluid hydrastis). Some bad cases require excision of the mucous membrane, the divided edge of this membrane being stitched to the skin.

Ulcer of the Rectum.—*Simple* ulcer is due to abrasion with fecal masses, and is apt to be single. Its base and edges are neither prominent nor hard. *Syphilitic* ulcer is a tertiary lesion commonest in women. There are numerous small ulcers, but little indurated, with sharp-cut edges which are not undermined. These ulcers fuse together and constitute one large irregular ulcer; fibrous tissue forms in the wall of the bowel, induration becomes noticeable, and stricture follows. There is profuse discharge, and fistulæ are apt to form. In syphilis there may be a breaking down of a huge gummy mass. *Tubercular* ulceration presents a conical

ulcer with overhanging edges and a pale-red base. There is some mucous discharge, some tenesmus, and a little pain. Dysentery, catarrh, neoplasms, and foreign bodies produce ulceration. The *symptoms* are constipation, burning pain on defecation, straining at stool, and blood and mucus in the stools. The *diagnosis* is made by the finger and the speculum.

Treatment.—In *simple* ulcer, empty the bowel with a saline, wash it out with hot water, introduce a speculum, touch the ulcer with pure carbolic acid or silver nitrate (gr. xl to ℥j), place the patient in bed, restrict to a liquid diet, and every day inject iodoform and olive oil or insufflate iodoform. In *tubercular* ulcer, improve the general health, send the patient to a genial climate or at least into the sunlight and fresh air, prevent constipation, give cod-liver oil, and wash out the rectum every day with hot water and insufflate iodoform. Touch the ulcer once a week with silver nitrate (gr. x to ℥j). In *syphilitic* ulcer, give antisyphilitic treatment and treat the ulcer locally as is done in tubercular ulcer. *Dysenteric* ulcer requires injections of hot water and the touching of the ulcer with pure carbolic acid and insufflations of iodoform.

Stricture of the rectum may arise from syphilitic tissue, from ordinary inflammatory tissue, from cicatrices of operations, from sloughing, from tubercular or dysenteric ulceration, and from cancer. The usual seat of simple stricture is from one inch to one and a half inches above the anus. The deposit may be limited to the submucous coat or all the coats may be involved.

Symptoms and Treatment.—The *symptoms* of rectal stricture are constipation, pain on defecation, straining at stool, blood and mucus in the stools, an open anus, and stools flattened out into ribbons. The stricture is found by the finger or by the bougie. Complete obstruction may come on, and dis-

tended abdomen with colic is very usual. The *treatment* is rest, non-stimulating diet, warm-water injections, mild laxatives, and hot hip-baths. Cocaine suppositories may be needed. Any existing disease is treated. Bougies are passed every other day. Use a soft-rubber bougie, warmed and oiled, and introduce it gently. If this method of gradual dilatation is employed the bougie must be used always. For fibrous strictures forcible dilation (divulsion) by a special instrument is employed or incision is practised. Incision (proctotomy) may be either external or internal. In internal proctotomy one or more incisions are made through the stricture down to healthy tissue, the first cut being in the middle line posteriorly. External proctotomy, which divides the sphincters, is apt to leave incontinence as a legacy. Electrolysis finds some advocates, but on what grounds it is difficult to see. In some cases the rectum should be removed. Complete obstruction calls for inguinal colostomy.

Cancer of the rectum may be epithelioma, but it is often scirrhus. It not unusually occurs before the thirty-fifth year. The retroperitoneal and inguinal glands are involved late or not at all. Extensive ulceration occurs. A hard ring is apt to encircle the rectum.

Symptoms and Treatment.—The *symptoms* of rectal cancer are like those of simple ulcer except that the pain is greater, the hemorrhage more severe, and constipation is apt to alternate with diarrhœa. The finger and the speculum make the diagnosis. *Palliative treatment* is as follows: Every day introduce a tube through the stricture, wash out the rectum with warm water, and after washing inject emulsion of iodoform (grs. x to ℥j of sweet oil). Injections of chloride of zinc (gr. j to ℥j of water) lessen the foulness of the discharge. In *operative treatment* internal proctotomy does some good. Excision of the rectum from below (Cripp's operation) is practised if not more than three inches require

removal, if the peritoneum is not invaded, and if the adjacent organs are free from disease. The peritoneum must not be opened in Cripp's operation. Excision of the rectum after excising a portion of the sacrum (Kraske's operation) is an operation which permits removal of the entire tube, and even of adjacent parts. If the peritoneum is opened, it is closed with sutures. It is well to precede a Kraske operation several weeks by an inguinal colostomy, which permits of cleansing the lower bowel from feces and allows the surgeon to operate with a fair chance of escaping infection. In obstruction from cancer, or in cases that do not permit of removal, inguinal colostomy is performed. It intercepts the feces from the cancerous region, allays pain, and prolongs life.

Foreign bodies in the rectum, if small, are extracted with forceps and the fingers; if large, ether must first be given and the sphincter must be dilated.

Wounds of the rectum require free drainage, antiseptic irrigation, and antiseptic dressing.

Ischio-rectal abscesses are situated in the ischio-rectal fossa. They travel in the line of least resistance, which is upward, and more often burst into the bowel than externally. They are caused by cold, by external traumatisms, or by perforations of the rectum by hard fecal masses. They may be tubercular. The *symptoms* are the same as those of abscess anywhere, the swelling, however, being brawny and fluctuation being hard to detect. The *treatment* is instant incision, irrigation, and packing with iodoform gauze or the insertion of a drainage-tube.

Fistula in ano is the track of an unhealed abscess. An abscess in the anal region is apt to refuse to heal because of the constant movement of the parts (respiration, coughing, passage of wind, defecation). The passage of feces will keep a fistula open. If a tubercular ulcer perforates, a

tubercular sinus forms. Fistula is often associated with phthisis pulmonalis, and is not unusually linked with piles, cancer, or stricture.

There are three varieties of fistula—the blind external (Fig. 167, A), the blind internal (Fig. 167, B), and the complete (Fig. 167, C). The *external* opening is usually near the anus, but may be far away, and there may be only one pathway or there may be several sinuses. In a healthy individual the external orifice is small and a mass of granulations sprout from it. In tuberculous fistula the external orifice is large and irregular, with thin and undermined edges, shows no

FIG. 167.—Fistula in Ano: A, blind external; B, blind internal; C, complete (Esmarch and Kowalzig).

granulations, extrudes small quantities of sanious pus, and the skin about it is purple and congested (Bowlby). In a fistula following an anal abscess the *internal* opening is just above the anus, between the two sphincters. In fistula following an ischio-rectal abscess the internal opening is above the internal sphincter. In an old fistula the track becomes fibrous and cannot collapse. The *symptoms* of fistula are passage of feces and wind through the opening and of a discharge which stains the clothing. A probe can be carried from the external opening into the bowel. After a time incontinence of feces is apt to come on, repeated attacks of inflammation thickening the rectum and destroying its sensi-

bility. From time to time the opening will block, and new abscesses may then form. In examining a fistula, use Brodie's probe, as its flat handle enables one to locate the direction a bent probe has taken.

Treatment.—In treating a fistula prepare the parts antiseptically, as antiseptic work, though it will not prevent pus, will limit suppuration. Pass a grooved director through the sinus, bring its point out externally, and lift up the tissues between the sinus and the surface. Incise the tissues (Fig. 168). Push the finger to the depth of the wound, to determine that the sinus does not ascend above the internal opening. Slit up the sinuses and scrape them. Curette the sinus, and if it is very fibrous clip it away with scissors and forceps. Cut away diseased skin; irrigate with corrosive-sublimate solution (1 : 1000); pack with iodoform gauze; and dress with gauze and a T-bandage. In forty-eight hours remove the dressings, irrigate with peroxide of hydrogen and then with corrosive sublimate (1 : 5000), dust in iodoform, insert lightly to the depths of the wound a piece of iodoform gauze, and reapply the dressings. Dress the wound thus every day until healing is almost complete. It is unnecessary to confine the bowels beyond forty-eight hours, at which period, if they have not moved, an enema is given. If the dressing be stained with feces, re-dress at once. Get the patient out of bed as soon as possible. Should an operation be undertaken if phthisis exists? Many of the old masters said *no.* Matthews sums up the modern view: In incipient phthisis, operate; in rapidly progressive fistula, operate whether cough exists or not; if much cough exists, do not operate unless the fistula is rapidly progressive; in the last stages of phthisis, do not operate.

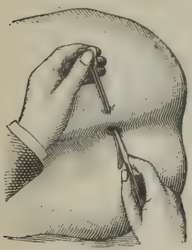


Fig. 168.—Operation for Fistula in Ano (Esmarch and Kowalzig).

Pruritus of the anus is a symptom, and not a disease. It may be due to piles, fissure, seat-worms, eczema, nerve-disturbance, kidney-disease, jaundice, constipation, opium-habit, torpid liver, dyspepsia, alcohol, tea, vesical calculus, smoking, urethral stricture, uterine disease, ovarian trouble, and mental disorder. The itching, which is fearful, is worse at night.

Treatment.—Remove the cause. Further, before going to bed wash the parts with very hot water, dry them, and apply at frequent intervals a mixture containing ʒj of campho-phenique and ℥j of water (Matthews). Matthews commends the following mixture: Chloral, ʒj; gum-camphor, ʒss; glycerin and water, each ℥j.[1] In this disease a "scarf-skin" forms, which must be made to peel off by iodine, pure carbolic acid, corrosive sublimate (grs. iv to ℥j of cosmoline), calomel (ʒij to ℥j of cosmoline), or campho-phenique.

Fissure of the anus is a crack at the anal orifice producing spasm of the sphincter. The pain is due to twigs of nerves upon the floor of the crack. Fissure is caused by constipation or traumatism. The *symptom* is violent burning pain, sometimes beginning during defecation, but usually at the end of the act, and lasting for some time. Constipation exists, and often pruritus. Examination discloses a fissure, usually at the posterior margin, running up the bowel one-quarter to one-half an inch. Piles often exist with fissure.

Treatment.—In *palliative treatment* prevent constipation, wash out the rectum with cold water, and apply an ointment made by evaporating ℥ij of the juice of conium to ʒij and adding it to ℥j of lanolin and grs. xij of persulphate of iron. In *operative treatment* stretch the sphincter, incise the floor of the fissure, and scrape it with a curette.

[1] *Diseases of the Rectum.*

XXVIII. ANÆSTHESIA AND ANÆSTHETICS.

Anæsthesia is a condition of insensibility or loss of feeling artificially produced. An *anæsthetic* is an agent which produces insensibility or loss of feeling. Anæsthetics are divided into—(1) *General anæsthetics*, as amylene, chloroform, ethylene chloride, ether, bromide of ethyl, nitrous oxide, and bichloride of methylene; (2) *Local anæsthetics*, as alcohol, bisulphide of carbon, chloride of ethyl, carbolic acid, ether spray, cocaine, ice and salt, and rhigolene spray.

General anæsthesia may be required to prevent the pain of labor and of surgical procedures; to produce muscular relaxation in herniæ, dislocations, and fractures; and to aid in diagnosticating abdominal tumors, joint diseases, and malingering.

Heart disease is not a positive contraindication to surgical anæsthesia. It is quite true that anæsthetics are dangerous in people with fatty hearts, but shock is equally dangerous, and the surgeon stands between the Scylla of anæsthesia and the Charybdis of shock. Whenever possible, *prepare* a patient for anæsthesia. Always examine the urine if the nature of the case allows time. If albumin exists, operation is not contraindicated; but the peril of anæsthesia is greater, and certain dangers are to be watched for and guarded against. If much albumin is present, postpone operation except in emergency cases. Give a purgative the night before. In the morning, allow no breakfast if the operation is early, but if the patient is very weak order a little brandy and beef-tea. If the operation is to be about noon, give a breakfast of some beaf-tea and toast or a little consommé; *never* give any food within three hours of the operation, but brandy is admissible if it is required. If the stomach is not empty at the time of operation, vomiting is inevitable and portions of food may enter the windpipe; if the stomach

contains no food, vomiting is less likely to happen, and even if the vomited matter enters the windpipe it will do little harm, as it consists chiefly of liquid mucus. Vomiting is dangerous also because of the great cardiac weakness which precedes and follows it. Before giving the anæsthetic see that artificial teeth are removed and that the patient does not have a piece of candy or a chew of tobacco in the mouth. Always have a third party present as a witness, because in the anæsthetic sleep vivid dreams often occur, and erotic dreams in women may lead to damaging accusations against the surgeon. Place the patient recumbent, and see that the clothing is loose, particularly that there is no constriction about the neck and abdomen. Do not have the head high unless this position is demanded by the exigencies of the operation. The anæsthetizer must have a mouth-gag, a pair of tongue-forceps, a hypodermic needle in *working* order, and solutions of strychnia, atropia, digitalis, and brandy. It is always well to have an electric battery at hand. Accidents, it is true, are rare, but they may happen at any time, and hence the surgeon should always be prepared for them. Any danger which arises must be met with promptness and decision, or action will be of no avail. Many surgeons give a hypodermatic injection of morphia a short time before operation, to steady the heart, prevent vomiting, and aid the bringing about of insensibility with very little of the anæsthetic.

The two favorite anæsthetics are ether and chloroform. Chloroform is more dangerous than ether in general cases, though it is more agreeable, less irritant to the lungs and kidneys, and quicker in its action. Recovery from chloroform is quicker and quieter than that from ether, but chloroform vomiting lasts longer than ether vomiting. Chloroform may induce sudden and even fatal syncope. Dr. Hare's experiments on animals show that chloroform may kill

through the respiration; but certain it is that clinically the danger of chloroform is paralysis of the heart, and this condition may come on so rapidly that death can occur almost before an attempt can be made to save life. If ether kills, it does so through the respiration, and not the heart, and there is usually time to undertake means of resuscitation, which means are apt to be successful. Chloroform is to be preferred to ether in the following cases: for children under ten years of age, in whom ether causes a great outflow of bronchial mucus which may asphyxiate; for people over sixty, at which age most persons have some bronchitis, and ether fills them up with mucus (ether irritates kidneys, which at the latter age are apt to be weak or diseased); for labor cases, when moderate anæsthesia only is required; for operations on the mouth and nose (unless the Trendelenburg chair is used, when ether can be employed). In cleft palate chloroform should always be used to limit cough and to minimize salivary flow. In ligation of a large artery which is overlaid by a vein ether must not be used, as it greatly enlarges the veins. Chloroform is preferred for patients with difficult respiration from any cause; for patients with kidney disease; for patients with diabetes; and in ovariotomy, because of a belief by many surgeons that ether causes oozing of blood. Ether is safer in patients with heart disease.

Administration of Chloroform.—In administering chloroform, have at hand a mouth-gag, tongue-forceps, a clean towel, a hypodermatic syringe, solutions of strychnine, atropine, and brandy, and, if possible, an electric battery. Use only *pure* chloroform (Squibb's). The patient must be recumbent. No special inhaler is required, but the drug can be given upon a thin towel, a napkin, or a piece of lint. The chloroform vapor must be well mixed with air. The chloroform is sprinkled on the fabric with a drop-bottle. Put the napkin well above the mouth, add five drops of

chloroform, and tell the patient to take deep and regular breaths. Add a few more drops of chloroform, and when the patient grows so accustomed to it as not to choke, turn the wet part of the fabric toward the face and place it near the mouth; do not touch the mouth with the wet lint, because it will blister. It is a good plan to smear the lips with cosmoline to prevent blistering. If the drug is given *gradually*, struggling is not usually violent or prolonged. Never pour on a large amount at one time. During the stage of excitement do not suspend the administration of chloroform unless respiration becomes difficult, in which case suspend it until the patient gets one or two respirations. Chloroform vapor is not inflammable, hence it is safer than ether when a hot iron is to be used about the face and when there is a lighted lamp or a stove in a small room.

FIG. 169.—Allis Ether-inhaler.

Administration of Ether.—Ether is given by means of an Allis inhaler (Fig. 169). Have at hand the same instruments as for chloroform. Place the dry appliance over the mouth and nose, let the patient take several breaths to gain confidence, pour a few drops of ether into the cone, let the patient take several more breaths, and so on, gradually increasing the amount of ether. Never suddenly add a large amount of the anæsthetic: it causes coughing and often vomiting. When the patient becomes thoroughly anæsthetized, diminish the amount of ether; when bleeding is profuse, do the same. If a hot iron is used about the face, take away the cone and fan away the ether before bringing the iron near. Have any light set high up, as ether vapor is heavier than air, and no explosion

is possible until it reaches the level of the flame. If the vapor takes fire, cover the patient's mouth and nose with a towel.

Anæsthetic State from Ether or Chloroform.—The inhalation of an anæsthetic produces irritation of the fauces, some cough, a profuse secretion of mucus, acts of swallowing, dilatation of the pupil, flushed face, and sometimes struggling (especially in children and in drunkards). The cough soon ceases, the respirations become rapid and often convulsive, the pulse becomes frequent, and the patient passes into a condition of active intoxication with preservation of sight and touch, loss of hearing and smell, diminution of pain and sensibility, and often with illusions or hallucinations. From this state many subjects (strong men and drunkards) pass into a stage of rigidity in which the muscles become rigidly fixed, the breathing impeded, the respirations stertorous, and the face bluish and congested. Too rapid forcing of the anæsthetic tends to cause rigidity, and a skilled anæsthetizer endeavors to avoid its production, because it is dangerous. The next stage is one of insensibility: the pupils are contracted, but may react slightly to light; the conjunctival reflex is gone; the lids are closed; if the arm is lifted and allowed to fall, it drops as a dead weight; the skin is cool and moist, and often wet with sweat; the respirations are easy and shallow; the pulse is slow; and there is complete unconsciousness to pain. If anæsthesia is deep, the contracted pupils will not react to light; if anæsthesia is profound, the pupils dilate, but will not react to light.

Always bear in mind that a dilated pupil reacting to light and associated with preserved conjunctival reflex means that anæsthesia is not complete; that a contracted pupil reacting to light and without conjunctival reflex means moderate anæsthesia; that a contracted pupil not reacting to light

and without conjunctival reflex means deep anæsthesia; that a dilated pupil not reacting to light and associated with lost conjunctival reflex means dangerously profound anæsthesia; that weak pulse and pallor may be due to nausea, but always require instant attention; that vomiting may be due to forcing strong vapor upon the patient, but that it may be due to his partially emerging from a state of insensibility.

Watch the pulse carefully to see if it becomes very weak, irregular, abnormally slow, or abnormally fast. Syncope may be due to nausea, shock, hemorrhage, or the giving of too much of the drug. Watch the respiration, and do not forget that the chest-walls and belly may move when no air is entering the lung; hence always *listen* to the breathing. Obstruction of the air-passages may be due to some foreign matter, as blood or vomit, lodging in the brachial tubes, windpipe, larynx, or pharynx; to falling back of the tongue (swallowing of the tongue); to closure of the epiglottis; or to the glottis being pushed against the pharyngeal wall by bending forward of the head. Some patients with occluded nostrils may fail to get enough air because of closure of the lips. A patient may appear to forget to breathe. Shock is manifested by deadly pallor, weak and irregular pulse, slow respiration, cold extremities, and a drenching sweat.

Treatment of Complications.—In rare cases œdema of the lungs occurs. This condition is treated by instant venesection, the inhalation of nitrite of amyl, and the administration of stimulants and nitro-glycerin. *Vomiting* due to too much anæsthetic is corrected by giving a few breaths of air; vomiting due to incomplete anæsthesia is amended by giving more of the vapor. When the patient vomits, hang the head over the edge of the bed, separate the jaws with the gag, and wipe out the vomited matter, mucus, and saliva. *Shock* is treated by diminishing the

amount of the anæsthetic given, by the hypodermatic injection of brandy, strychnine, or atropine (the last-named drug is very useful when there is a profuse sweat), by surrounding the patient with hot bottles, or by wrapping him in hot blankets and lowering the head of the bed. A tendency to *syncope* requires lowering of the head of the bed, suspension of the anæsthetic, and hypodermatic injection of strychnine. In *extreme syncope*, which is most apt to occur from chloroform, suspend the anæsthetic, open the mouth with the gag, draw the tongue forward, make *slow* artificial respiration, not waiting for breathing to cease (which it tends rapidly to do), and lower the head of the bed. If the patient does not *at once* improve, invert him completely, holding him by the legs and continuing artificial respiration by compressing the sternum (Nélaton). By continuing artificial respiration the blood is urged on through the heart. Give hypodermatic injections of ether, brandy, strychnine, or even of ammonia. Put mustard over the heart and spine. Employ faradism to the phrenic nerve (one pole to the epigastric region, the other to the right side of the root of the neck). Let fresh air into the room, put hot-water bottles around the legs, apply friction to the extremities, wrap the patient in hot blankets, give an enema of brandy, and hold ammonia or nitrite of amyl to the nose.

"Forgetting to breathe" is met by removing the inhaler and waiting a moment; a breath will usually be taken now, but if it is not taken open the mouth and pull forward the tongue; this causes a reflex inspiration. *Obstruction* to breathing from bending forward of the head may be amended by changing the position of the head or by pulling forward the tongue. *Cyanosis*, if slight, is met by continuing the anæsthetic and by carrying the patient quickly into the stage of relaxation; but if the condition grows worse suspend the drug, dash cold water in the face, force open the jaws, pull

forward the tongue, and make artificial respiration until a breath is taken. "Swallowing the tongue" is corrected by pulling the tongue forward. If it tends to recur, lay the head upon its side or keep the tongue anchored with forceps. *Closure of the epiglottis* is corrected by pulling the patient's head beyond the end of the table and pushing strongly back upon his forehead. This manœuvre lifts the hyoid bone, and with it the epiglottis. The epiglottis can be lifted by passing a spoon-handle over the dorsum to the base of the tongue and pressing forward. If, in obstruction to respiration, the above means fail, make artificial respiration at once; if obstruction continues, perform tracheotomy.

After stopping the anæsthetic in an ordinary case have the patient carefully watched until consciousness and intelligence are entirely restored. The face is washed with cold water; the patient is kept recumbent; if vomiting occurs, his head is hung over the edge of the bed and the mouth is subsequently wiped out. No food should be taken for at least eight hours. If vomiting occurs, draughts of *hot* water will relieve it by washing out the mucus from the stomach.

Primary Anæsthesia.—Instruct the patient to count out aloud and to hold one arm above his head. Give the anæsthetic. In a short time he becomes mixed in his count and his arm sways or drops to the side. There is now a period of insensibility to pain lasting only about half a minute, and during this period a minor operation can be performed. The patient quickly reacts without vomiting from primary anæsthesia (Packard).

Local Anæsthesia.—*Freezing with Ice and Salt.*—Take one-quarter of a pound of ice, wrap it in a towel, and break it into fine bits; add one-eighth of a pound of salt; then place the mixture in a gauze bag and lay it upon the part. The surface becomes pallid and numb, and in about fifteen minutes is decidedly analgesic. *Spray of rhigolene* freezes

in about ten seconds. It is highly inflammable. *Chloride of ethyl* comes in hermetically-sealed glass tubes. Break the end of the tip of the tube and hold the bulb in the palm: the warmth of the hand causes the fluid to spray out. Hold the tube some little distance from the part and let the fine spray strike the surface. The skin blanches and whitens, and is ready for the operation in about thirty seconds. *Ether-spray* anæsthesia was suggested by Benjamin Ward Richardson.

Cocaine Hydrochlorate.—Always bear in mind that cocaine is more dangerous than ether (Richardière made eleven autopsies in deaths from cocaine). Never use over two-thirds of a grain upon a mucous surface, and never inject hypodermatically more than one-third of a grain. The urethra is a particularly dangerous region, and so is the face. Mild cases of cocaine-poisoning are characterized by great tremor, restlessness, pallor, dry mouth, talkativeness, and weak pulse. In severe cases there is syncope or delirium. Death may arise from paralysis or from fixation of the respiratory muscles (Mosso). Cases with a tendency to respiratory failure require the hypodermatic injection of strychnine. In cases with tetanic rigidity of muscles give enemata of chloral, hypodermatic injections of nitroglycerin, or inhalations of the nitrite of amyl. In cases marked by delirium, if the circulation is good give chloral or hyoscine. In any case give stimulants, employ a catheter, and favor diuresis. Cocaine-poisoning is always followed by a wakeful night. Cocaine should not be used if the kidneys are inefficient. In using cocaine try to prevent poisoning. Have the patient recumbent. One minute before giving the cocaine, administer one drop of a 1 per cent. alcoholic solution of trinitrine, repeating the dose once or twice during the operation. In operation on a finger, after making the part anæmic tie a tube around the root of the digit before inject-

ing cocaine, and after the operation gradually loosen the tube. Merck prepares a far safer agent than the hydrochlorate, and that is the phenate of cocaine. This is a honey-like material, soluble in alcohol. It is used locally in from 5 to 10 per cent. solutions. It takes longer to act than does the hydrochlorate, and it coagulates the tissue-albumin, and thus absorption is lessened. It causes anæmia, anæsthesia, and retards germ-growth (Kyle). Glück and Bartholow some time ago advised a mixture composed of cocaine hydrochlorate and carbolic acid.

XXIX. BURNS AND SCALDS.

Burns and scalds are injuries due to the action of caloric. Scalds are due to heated fluids or vapors. There is no true pathological difference between burns and scalds. Dupuytren classifies burns into six degrees, as follows: (1) characterized by erythema; (2) characterized by dermatitis with the formation of vesicles; (3) characterized by partial destruction of the skin, which structure is not, however, entirely burnt through; (4) characterized by destruction of the skin to the subcutaneous tissue; (5) characterized by destruction of all superficial structures and of part of the muscular layer; (6) characterized by "carbonization" of the whole thickness of the muscles.

The *symptoms* are local and constitutional. *Local symptoms* are pain and inflammation, which vary in nature, in intensity, or in degree according to the extent of damage done. *Constitutional symptoms* are shock, followed by a severe reactionary fever, with a strong tendency to congestion of internal parts. Sepsis is not infrequent. The stages are often designated as *prostration*, *reaction*, and *suppuration*. Death may be due to shock, to sepsis, to exhaus-

tion, to congestion of the brain, lungs, or kidneys, or to Curling's ulcer of the duodenum.

Treatment.—The *local treatment* of slight burns (as sunburn) is to wrap up the parts in a saturated solution of bicarbonate of soda, a strong solution of Epsom salt, or a 1 : 8 solution of phénol sodique. In burns of moderate degree a mixture of zinc ointment with iodoform, though not antiseptic, is a comfortable dressing; but all severe burns should be treated antiseptically. In a severe burn, cut away the clothing, avoid exposure to cold, wash the part with a solution of peroxide of hydrogen and then with a warm solution of boracic acid, open the vesicles with an aseptic needle, dust on iodoform, and dress with aseptic cotton. Change the dressings no oftener than is required, and at each change wash the burn with peroxide of hydrogen and boracic acid, take away sloughs, and reapply iodoform and cotton. Where extensive destruction of tissue has taken place, use splints and extension to limit contractures, and skin-graft as soon as possible. If granulation is slow, stimulate with copper-sulphate or mild silver-nitrate solutions. Exuberant granulations require burning down. Flabby granulations require pressure. Carron oil, which consists of linseed oil and lime-water, allays the pain of a burn, but it is a foul and dirty preparation. When an extremity has been carbonized amputation must be performed. In *constitutional treatment*, react from shock; combat pain with opium; keep the bowels and kidneys active. If suppuration occurs, give tonics, stimulants, and concentrated foods. Complications are treated according to general rules.

Scalds of the glottis are due to the inhalation of steam or of ignited gas. A child may scald the glottis by trying to drink from the spout of a kettle (Moullin). The *symptoms* are pain, dysphagia, and dyspnœa. Œdema of the glottis quickly comes on. The *treatment* is tracheotomy or intuba-

tion of the larynx in severe cases; in mild cases, scarification of the larynx.

Effects of Cold.—*Local Effects.*—Cold produces numbness, prickling, a feeling of weight, redness of the surface followed by stiffness, local insensibility, and mottling or pallor. Sudden intense cold causes the formation of blebs, the coagulation of blood in the superficial veins, and violent pain in the limb. Cold locally produces frost-bite (p. 118). The *constitutional effects* of cold are at first stimulating, then depressing, and are exhibited by uneasiness, pain, and an intense drowsiness which, if yielded to, is the road to death by way of internal congestion. Death from prolonged cold resembles in appearance death from apoplexy. Death from sudden and overwhelming cold is caused by anæmia of the brain from weak circulation and capillary embolism. To bring a partly-frozen person into a warm room will cause death by embolism.

Treatment.—Frost-bite is treated as outlined on page 118. When a person is nearly frozen to death, place him in a *cool* room, but under no circumstance in a cold bath, make artificial respiration, rub him down with flannel soaked in alcohol or in whiskey, and follow this by rubbing with dry hands. After a time wrap the patient in warm blankets and give an enema of brandy. Mustard plasters are to be applied over the heart and spine. As soon as swallowing is possible brandy is administered by the mouth. As the condition improves gradually raise the temperature of the room and give *hot* drinks.

Chilblain, or **pernio,** is the secondary effect of cold. It usually appears as a local congestion upon the toes, the fingers, or the nose, and it is apt now and then to inflame and ulcerate. A chilblain is apt to become congested by approaching a fire or by taking exercise, and when congested it itches, tingles, and stings. Frequent attacks of

congestion produce crops of vesicles; these vesicles rupture and expose an ulcer which in rare instances sloughs.

Treatment.—Prevent congestion of the legs and feet if chilblain affects the toes. Order large shoes and woollen stockings and forbid tight garters. The patient with pernio must take regular outdoor exercise and must not loiter around a hot fire. Every morning and evening he should take a general cold sponge bath followed by rubbing with alcohol and frictions with a coarse towel, and he should sleep with warm stockings on or with his feet upon a hot-water bag. When a chilblain is only a congested spot it should be washed twice a day in cold salt water, rubbed dry with flannel, and subjected to applications of tincture of iodine and soap liniment (1 : 2), tincture of cantharides and soap liniment (1 : 6), or equal parts of turpentine and olive oil (W. H. A. Jacobson). Jacobson says itching is relieved by painting belladonna liniment upon the part and allowing it to dry. If vesicles form, paint with contractile collodion; if ulcers form, dress antiseptically. If ulcers are sluggish, use equal parts of resin cerate and spirits of turpentine. A good antiseptic and protective is the following: Oxide of zinc, grs. vj; chloride of zinc, gr. xx; gelatin, ℥ij; Distilled water, ʒj.

XXX. DISEASES OF THE SKIN AND NAILS.

Dermatitis venenata results from irritants and from garments containing arsenic, but is generally due to rhus-poisoning. Rhus-poisoning arises from the poison-oak, the poison-ash, the poison-ivy, and other species of sumach. Actual touching of the plants is not always necessary. The *symptoms* are burning and itching, redness and œdema of the face and hands. A vesicular eruption begins between the fingers, and the eruption and the inflammation spread

widely over the body. There may be some slight fever. The *treatment*, when a moderate area is involved, comprises the application of cloths wet with black wash or lead-water and laudanum. If an extensive area is involved, apply grindelia robusta (ʒiv to Oj of water) or moisten the surface frequently with sweet spirits of nitre. For the face use borated-talc powder. Oxide-of-zinc ointment containing 10 grs. of carbolic acid to ℥j gives great relief. A 1 : 8 solution of phénol sodique allays pain and itching.

Furuncle, or boil, is an acute and circumscribed inflammation and suppuration of a hair-follicle, a sebaceous gland, and the adjacent connective tissue. A boil is caused by infection of a hair-follicle, through a slight wound (by scratching, shaving, etc.), with the staphylococcus pyogenes aureus. Boils are very common during Bright's disease, diabetes, gout, tuberculosis, and disorders of menstruation and digestion. Boils are commonest in the spring, and sometimes an epidemic of furunculosis appears in a hospital, a jail, or an asylum. The *symptoms* of a boil are as follows: A red elevation appears, which stings and itches; this elevation enlarges and becomes dusky in color; a pustule forms, that ruptures and gives out a very little discharge which forms a crust. Inflammatory infiltration of adjacent connective tissue advances rapidly, and the boil in about three days consists of a large, red, tender, and painful base capped by a pustule and some crusted discharge. In rare instances, at this stage, absorption occurs, but in most cases the swelling increases, the discoloration becomes dusky, the skin becomes œdematous, the pain becomes fierce and pulsatile, and the centre of the boil becomes lifted up. About the seventh day rupture occurs, pus runs out, and a "core" of necrosed tissue is found in the centre of a ragged opening. In a day or two more the core will be discharged and healing by granulation will occur. A *blind boil* lasts only three or four

days and has no core. The constitution often shows reaction during the progress of a boil. Boils may be either single or multiple. The development of boil after boil is known as "furunculosis." Boils are commonest upon the neck and the back. The *treatment* consists of crucial incision, removal of necrotic tissue, irrigation with peroxide of hydrogen and corrosive sublimate, and antiseptic dressing.

Aleppo boils (endemic boils of the tropics) are papules appearing upon the exposed parts of the body. These papules, which ulcerate and do not cicatrize for at least a year, are due to a pathogenic bacterium and leave ineradicable scars.

Carbuncle (benign anthrax) is a circumscribed infectious inflammation of the deeper layer of the true skin and of the subcutaneous tissue, with fibrinous exudation in which multiple foci of necrosis arise and the tissue adjacent to each necrotic plug becomes gangrenous. The infection takes place through a hair-follicle. It is really a boil with extensive infiltration of adjacent tissues. A boil can become a carbuncle, and pus from a carbuncle inoculated into a healthy person may cause either a boil or a carbuncle. The causative organism seems to be the staphylococcus pyogenes aureus. The local *symptoms* in the start resemble those of a boil, but the constitution sympathizes from the beginning (a chill and a septic fever) and the pain is agonizing. The inflammatory area enlarges enormously, is boggy to the touch, is dusky in color, is œdematous, and the skin is not freely movable over the deeper parts. In a few days many pustules appear, each pustule marking the site of a focus of necrosis. Large vesicles filled with bloody serum are frequently met with. In some cases, about the tenth day, the pustules rupture, the necrotic plugs are discharged, and the case slowly progresses toward cure; but in many cases the carbuncle spreads at the periphery while pustules

are rupturing near the centre of inflammation, and pus forms in the deeper tissues, reaching the surface through many small openings each of which is partly blocked by a plug of dead tissue. A carbuncle in this stage resembles a honeycomb, discharges bloody pus, and large masses of skin and subcutaneous tissue are destroyed. The entire carbuncular mass may become gangrenous, and a sudden and almost complete cessation of pain points to this complication. An ordinary carbuncle remains acute for about three weeks, but healing requires a month more. The most dangerous positions for a carbuncle are the face and neck (tends to produce septic phlebitis, septic clots in the cerebral sinus, or infective emboli). The most usual positions for carbuncle are the neck, the back, and the buttocks. The diagnosis of carbuncle is made by noting the multiple foci of necrosis and the profound constitutional involvement.

Treatment.—Give ether, make free crucial incisions, remove dead and necrosing tissue with the scissors and forceps, curette pockets, stop hemorrhage by pressure and hot water, cauterize with *pure* carbolic acid, dust with iodoform, pack with iodoform gauze, and dress with corrosive-sublimate gauze. Every day, or several times a day, remove the dressings, wash with peroxide of hydrogen, irrigate with corrosive-sublimate solution, dust in iodoform, and reapply the iodoform gauze and antiseptic gauze. Secure sleep by morphia, give quinine, milk punch, and nourishing diet, and attend to the bowels and kidneys.

Clavus, or Corn.—A corn is a tender, painful, and circumscribed thickening of the epidermis, and is commonest over one of the joints of the toes. *Hard* corns are situated on exposed parts of the digits; *soft* corns appear between the digits and are kept constantly moist. Corns are caused by pressure.

Treatment.—By wearing well-fitting boots corns upon the

toes will usually disappear. Soak the feet often in water containing bicarbonate of soda, dry them, and apply circular corn-plasters to the corn, to take off the pressure of the boot. Another method is to touch the corn with iodine every night and pare away the hard tissue every morning. An old and valuable plan is to paint the corn every night with a mixture composed of salicylic acid, ʒiss; extract of cannabis indica, grs. x; and collodion, ℥j, and to scrape this mixture away every morning. *Soft* corns are treated by washing the feet often with ethereal soap, drying, gently removing the soft epithelium, dusting with borated talc, and placing absorbent cotton between the toes. Incurable soft corns require the freshening of the adjacent sides of the two toes and suturing them together (thus converting two toes into one). In inflamed corns employ rest and lead-water and laudanum, and let out pus when it forms. Remember that in old persons the cutting of a corn may cause senile gangrene. In the inflamed and painful feet of a person who has corns, nothing gives so much relief as washing them with ethereal soap, soaking in hot water, and wrapping the feet for half an hour in cloths wet with a mixture composed of linseed oil and lime-water, each, ℥ij, and spirits of camphor, ʒj.

Warts.—(See p. 215.)

Onychia is inflammation of the matrix of the nail. A "run-around" is suppuration of the matrix and the root of the nail, of traumatic origin. It requires incision, trimming away of the buried edge of the nail, and packing with iodoform gauze. *Malignant onychia*, which is inflammation and ulceration of the entire matrix, occurs in persons with dilapidated constitutions. This condition requires removal of the entire nail, cauterization of the matrix, dressing with iodoform gauze, and the internal use of stimulants, tonics, and nourishing diet. *Ingrown toe-nail* is due either to lateral hypertrophy of the edge of the nail or to the forcing

of the soft tissues over the margin of the nail. The condition is treated by splitting the nail, removing the piece of nail, the soft tissue, and the adjacent matrix, and dressing antiseptically.

XXXI. DISEASES AND INJURIES OF THE LYMPHATICS.

Lymphangitis is inflammation of lymphatic vessels. *Reticular* lymphangitis, which is inflammation of lymphatic radicals, is seen in some circumscribed inflammations of the skin. It is apt to attack the hands, causing redness and swelling, fading at the point of initial trouble while it spreads at the periphery; it is caused by micro-organisms derived from decomposing animal matter (Rosenbach). Erysipelas also causes it (see *Erysipelas*). *Tubular* lymphangitis, which is due to the entry into the lymphatic ducts of virulent micro-organisms or their products, is seen in dissection-wounds, septic wounds, snake-bites, etc. It is announced by œdema and by minute hard red streaks running from the wound up the extremity. Suppuration may occur.

Lymphadenitis, or inflammation of the glands, may follow lymphangitis or may be due to the deposition of infective material, the lymph-vessels not being inflamed. In septic lymphadenitis there are pain, tenderness, and swelling. In severe cases there are chill and septic fever. Suppuration may arise. The *treatment* is to drain and asepticize the wound, to apply over the glands and vessels iodine and blue ointment or ichthyol, and to employ rest and compression. Internally, milk punch, quinine, and nourishing diet are required. If suppuration occurs, incise and drain.

Acute lymphadenitis, or acute inflammation of lymphatic glands, may follow lymphangitis or may be due to tubercle, syphilis, glanders, cold, or traumatism. Suppuration may or

may not occur. In inflammatory lymphadenitis there are pain, heat, and nodular swelling. In severe cases there is fever. The *treatment* is to asepticize any area of infection, place the glands at rest, apply cold and lead-water and laudanum, or inject into the gland every day 5 m. of a 3 per cent. solution of carbolic acid to prevent suppuration. If pus forms, evacuate, drain, and asepticize.

Chronic adenitis is almost invariably syphilitic or tubercular. It requires constitutional treatment and the local use of ichthyol, iodine, or blue ointment.

Lymphangiectasis (varicose lymphatics), or dilatation of the lymphatic vessels, is due to obstruction. It results, as a rule, from chronic lymphangitis or the pressure of a tumor, and is most usually situated in the pubic, the inguinal, or the scrotal regions or on the inner side of the thigh. There are two forms: the *varicose*, in which the vessels have a tortuous outline, like varicose veins, but are covered only by surface epithelium; and *lymphatic warts* (lymphangioma circumscriptum), in which wart-like masses spring up, these masses being covered with epithelium and filled with lymph. In most cases of lymphangiectasis there is considerable hard œdema. Rupture of the dilated vessel causes a flow of lymph (*lymphorrhœa*).

Lymphangioma is an advanced stage of lymphangiectasis (p. 209). The *treatment* in mild cases is to pierce each vesicle with the minus pole of a galvanic battery and pass a current. In severe cases destroy the mass with the Pacquelin cautery or excise it with a knife or with scissors.

Elephantiasis.—*True* elephantiasis (elephantiasis Arabum) is chronic hypertrophy of the skin and subcutaneous tissues following upon a lymphangiectasis produced by a nematode worm (the filaria sanguinis hominis). *Spurious* elephantiasis is hypertrophy of the skin and subcutaneous tissue due to chronic inflammation (in a leg which possesses an ancient

ulcer, or in the scrotum of a man with urinary fistula). The *treatment* is massage and bandaging, sometimes ligation of the artery of supply, extirpation, or amputation.

Malignant Lymphoma, or Hodgkin's Disease.—(See p. 203).

XXXII. BANDAGES.

A bandage is a fibrous material which is rolled up and is then employed to retain dressings, applications, or appliances to a part, to make pressure, or to correct deformity. It may be made of plain gauze, of gauze infiltrated with plaster of Paris or soaked in silicate of sodium, of gauze wet with corrosive-sublimate solution, of flannel, of calico, or of unbleached muslin. Unbleached muslin, which is the best material for general use, is washed to remove the sizing, is torn into strips, and the edges are stripped of selvage. One end is folded to the extent of six inches, this is folded upon itself again and again until a firm centre is formed, and over this centre the bandage is rolled. In a well-rolled bandage the centre cannot be pushed out of the roll.

A *cylindrical* part of the body may be covered by a *circular* bandage, each turn exactly covering the previous turns. A *conical* part may be covered by a *spiral* bandage, each turn ascending a little higher than the previous turn. As each turn of a spiral bandage is tight at its upper and loose at its lower edge, the *reverse* was devised to correct this inequality; hence a conical part should be covered by a *spiral reversed* bandage. To make a reverse hold the roller in the right hand (do not have more than six inches of slack), place the thumb across the fresh turn, fold the bandage down without traction, and do not make traction until the turn has been carried well around the limb. A projecting point is covered with *figure-of-8* turns. The groin, shoulder, breast, or axilla can be covered by figure-of-8 turns, each succeeding turn ascend-

ing and covering two-thirds of the previous turn and forming a figure like "the leaves on an ear of corn." Such a figure is called a "spica." In bandaging an extremity the peripheral turns should be tighter than the turns nearer the body. Never apply a tight bandage to the leg or the arm without including the foot or the hand. In firm dressings leave the fingers exposed, and use them as an index of the condition of the circulation in the part.

Spiral Reversed Bandage of the Upper Extremity.—In making this form of bandage, use a roller two and a half inches wide and eight yards long. Take a circular turn about the wrist, and a second turn to hold the first; pass obliquely across the back of the hand to the extremities of the fingers; ascend the hand to the root of the thumb by several spiral turns; cover the wrist by a figure-of-8; ascend the forearm by spiral reversed turns; cover the elbow by a figure-of-8, and the arm by spiral reversed turns; end the bandage by two circular turns, and pin them (Pl. 11, Fig. 4).

Spiral Bandage of All the Fingers (Gauntlet).—The gauntlet bandage requires a roller one inch wide and one and a half yards long. Take two circular turns around the wrist, pass obliquely across the wrist to the root of the thumb, and descend to its tip by spiral turns; cover in the thumb by spiral reverses, and return to the wrist. Cover in each successive finger in the same manner, and terminate by two circular turns around the wrist (Pl. 11, Fig. 2).

Spiral Bandage of the Palm or Dorsum of the Hand (Demi-gauntlet).—The demi-gauntlet requires a roller one inch wide and four yards long. This bandage has only a limited value; it must not be applied tightly, as it makes much pressure at the finger-roots, but leaves the fingers free. If it is desired to cover the palm, supinate the hand; if to cover the dorsum, pronate the hand. Take two circular turns around the wrist, sweep around the root of the thumb, and

1. Oblique or Crossed Bandage of the Angle of the Jaw; 2. Gibson's Bandage; 3. Recurrent Bandage of the Head; 4. Crossed Figure-of-8 Bandage of both Eyes; 5. Barton's Bandage or Figure-of-8 of the Jaw; 6. Figure-of-8 Bandage of the Elbow.

return to the point of origin. Treat each finger in the same way. End by circular turns around the wrist (Pl. 11, Fig. 1).

Spica of the Thumb.—For this bandage use a roller one inch wide and three yards long. Start at the wrist, and reach the tip of the thumb as in applying a spiral bandage of a finger. Make a series of ascending figure-of-8 turns between thumb and wrist, each ascending turn overlying two-thirds of the previous turn; terminate with a circular of the wrist (Pl. 11, Fig. 3).

Spiral Reversed Bandage of the Lower Extremity.—Take a roller two and a half inches wide and seven yards long, and make two circular turns just above the malleoli, and an oblique turn across the dorsum of the foot to the metatarso-phalangeal articulation; make a circular turn, and cover the foot with spiral reversed turns; return to the ankle by a figure-of-8; ascend the leg by spiral reverses; cover the knee by a figure-of-8, and the thigh by spiral reverses; terminate by two circular turns (Pl. 11, Fig. 6).

Bandage of the Foot covering the Heel (American Bandage of the Foot).—Take a roller two and a half inches wide and seven yards long. The bandage is begun as is a spiral reversed bandage of the lower extremity. After the foot is well covered by ascending spiral reversed turns, carry the bandage directly around the point of the heel and return to the instep; from this point carry it around the back of the ankle, down the side of the heel, under the heel to the instep, around the ankle in the opposite direction, down the opposite side of the heel, and under the heel to the instep; take the roller to above the malleoli, and end by a circular turn (Pl. 12, Fig. 2).

Bandage of the Foot not covering the Heel (French Method).—Take a roller two and a half inches wide and six yards long. Make a spiral reversed bandage of the foot and a figure-of-8 of the ankle-joint (Pl. 12, Fig. 1).

Spiral Bandage of the Foot covering the Heel (Ribble's Bandage; Spica of the Instep).—Take a roller two and a half inches wide and six yards long. Apply as a spiral reversed bandage of the lower extremity until the metatarsus is well covered. Carry the bandage, parallel with the margin of the foot (the inner or outer margin, according as to whether it is the left foot or the right), around the posterior aspect of the heel, along the opposite margin of the foot to cross the original turn at the median line of the dorsum. Make a number of these ascending turns, each turn covering in three-fourths of the previous turn; terminate by circular turns above the ankle (Pl. 12, Fig. 3).

Crossed Bandage of Both Eyes (Figure-of-8 of Both Eyes).—Take a roller two inches wide and six yards long. Make a circular turn around the forehead from right to left, a second turn to hold the first, a turn downward over the left eye, under the left ear, around the back of the neck,

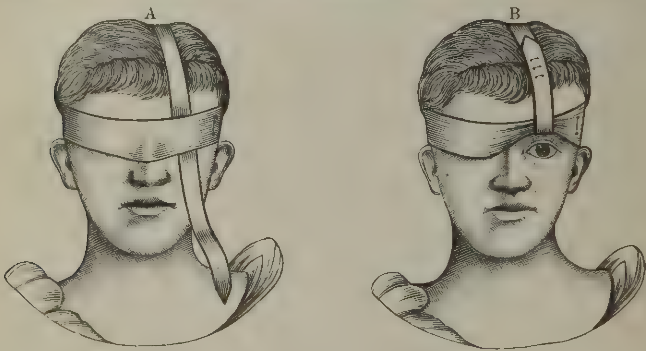


Fig. 170.—Borsch's Eye-bandage: A, first step; B, second step.

and upward under the right ear and over the right eye; repeat these turns, and terminate by a circular turn of the forehead (Pl. 10, Fig. 4).

Borsch's eye-bandage is convenient and useful (Fig. 170).

1 Demi-gauntlet Bandage; 2, Gauntlet Bandage; 3, Spica of the Thumb; 4, Spiral Reverse Bandage of the Upper Extremity; 5, Recurrent Bandage of Stumps; 6, Spiral Reverse Bandage of the Lower Extremity.

Barton's Bandage (Figure-of-8 of the Jaw).—Take a roller two inches wide and five yards long. Place the initial extremity of the bandage behind the inion; pass over the right parietal bone, across the vertex, down the left side in front of the ear, under the chin, up the right side in front of the ear, across the vertex, and across the left parietal bone to the point of origin. A turn is now taken forward along the right side of the jaw to the chin, and backward along the left side of the jaw, from the chin to the nape of the neck; repeat these turns, and pin the points of junction (Pl. 10, Fig. 5). In Barton's bandage the ear lies in a triangle. The bandage may be finished by circular turns around the forehead. Barton's bandage is used for fracture of the lower jaw.

Gibson's Bandage.—Take a roller two inches wide and six yards long. Make three vertical turns around the head and the jaw in front of the ear; reverse the bandage above the level of the ear, and carry it horizontally around the forehead and head three times; drop the bandage to the nape of the neck, and take three turns around the neck and jaw; terminate by taking from the nape of the neck a half turn upward, carrying the bandage forward to the forehead, and pinning it over the neck and over the forehead. Pin each point of junction (Pl. 10, Fig. 2). Gibson's bandage is used for fracture of the lower jaw.

Crossed Bandage of the Angle of the Jaw (Oblique Bandage of the Jaw).—Take a roller two inches wide and six yards long. Make a circular turn around the forehead toward the affected side, and a second turn to hold the first; drop to the back of the neck; come forward on the sound side, under the ear and chin; now make a series of turns around the head and jaw, in front of the ear on the injured side, but back of the ear on the sound side: these turns successively *advance* on the sound side only; terminate by

going backward under the ear of the sound side to the nape of the neck, and then by taking two circular turns around the forehead (Pl. 10, Fig. 1). This bandage is used for fractures of the ramus of the jaw and for holding dressings upon the face and the cranium.

Spica of the Groin (Figure-of-8 of the Thigh and Pelvis). —For one groin the roller is three inches wide and seven yards long; for both groins, three inches wide and ten yards long. Take two circular turns, from right to left, around the waist, then down over the front of the right groin, around the back of the thigh, up over the front of the right thigh, around the waist, down over the front of the left groin, around the back of the thigh, up over the left groin, and around the waist. The map being thus laid out, the turns are continued and ascended, each turn overlying one-third of the previous turn, and the bandage is completed by a circular turn around the waist (Pl. 12, Fig. 4). Pin the crossed pieces.

Spica of the Shoulder.—Take a roller two and a half inches wide and seven yards long. Make a circular turn and several spiral reversed turns around the upper arm; then, coming from behind forward, carry the bandage over the shoulder, across the front of the chest, through the opposite arm-pit, and return across the back to the shoulder. Make successive and advancing turns (Pl. 13, Fig. 6).

Figure-of-8 bandages of the breast, the elbow, the neck and axilla, and of both shoulders (posterior figure-of-8) are shown on Plate 10 (Fig. 6), Plate 12 (Figs. 5, 6), and Plate 13 (Figs. 1-6).

Velpeau's Bandage.—Take a roller two and a half inches wide and ten yards long. Place the palm of the hand of the injured side upon the shoulder of the sound side, interposing cotton between the arm and the side. Start at the axilla of the sound side posteriorly, cross the back to the

1. Figure-of-8 Bandage of the Ankle; 2, Method of Covering the Heel; 3, Spica of the Instep; 4, Spica of the Groin; 5, Posterior Figure-of-8 of both Shoulders; 6, Figure-of-8 of Neck and Axilla.

shoulder of the injured side, down the front of the arm and under the arm just above the elbow, returning to the point of origin; repeat this turn, but, on reaching the axilla the second time, cross the back and pass around the chest, including the arm; keep on with these turns, each alternate turn going over the injured clavicle, each alternate turn encircling the arm and the body, the first turns advancing and the second turns ascending (Pl. 13, Fig. 4). Pin the crossed pieces. This bandage is used for fracture of the clavicle.

Desault's Apparatus.—This apparatus consists of three rollers, a pad, and a sling. Each roller is two and a half inches wide and seven yards long. The pad, which is wedge-shaped, is inserted into the axilla with the base up. The *first roller* is used to hold the pad (Pl. 13, Fig. 1). The *second roller* binds the arm to the side over the pad. This pad is a fulcrum, the shoulder is the weight, the arm is the lever, and the second roller of Desault corrects the inward deformity of a fractured clavicle (Pl. 13, Fig. 2). The *third roller* corrects the downward and forward displacement. It starts in the axilla of the sound side anteriorly, crosses the chest to the shoulder of the injured side, runs down the back of the arm, around the elbow, and crosses the chest to the point of origin, forming the anterior triangle; it is now carried through the axilla of the sound side to the back, crosses the back to the shoulder of the injured side, runs down the front of the arm, around the elbow, and across the back to the axilla of the sound side, forming the posterior triangle (Pl. 13, Fig. 3). The formula for the Desault bandage is: Start in the axilla of the sound side anteriorly, run from the axilla to the shoulder, from the shoulder to the elbow, from the elbow to the axilla, and pass to the back; from the axilla to the shoulder, from the shoulder to the elbow, from the elbow to the axilla, and pass

to the front. Pin the crossed pieces and hang the hand in a sling (Pl. 13, Fig. 3).

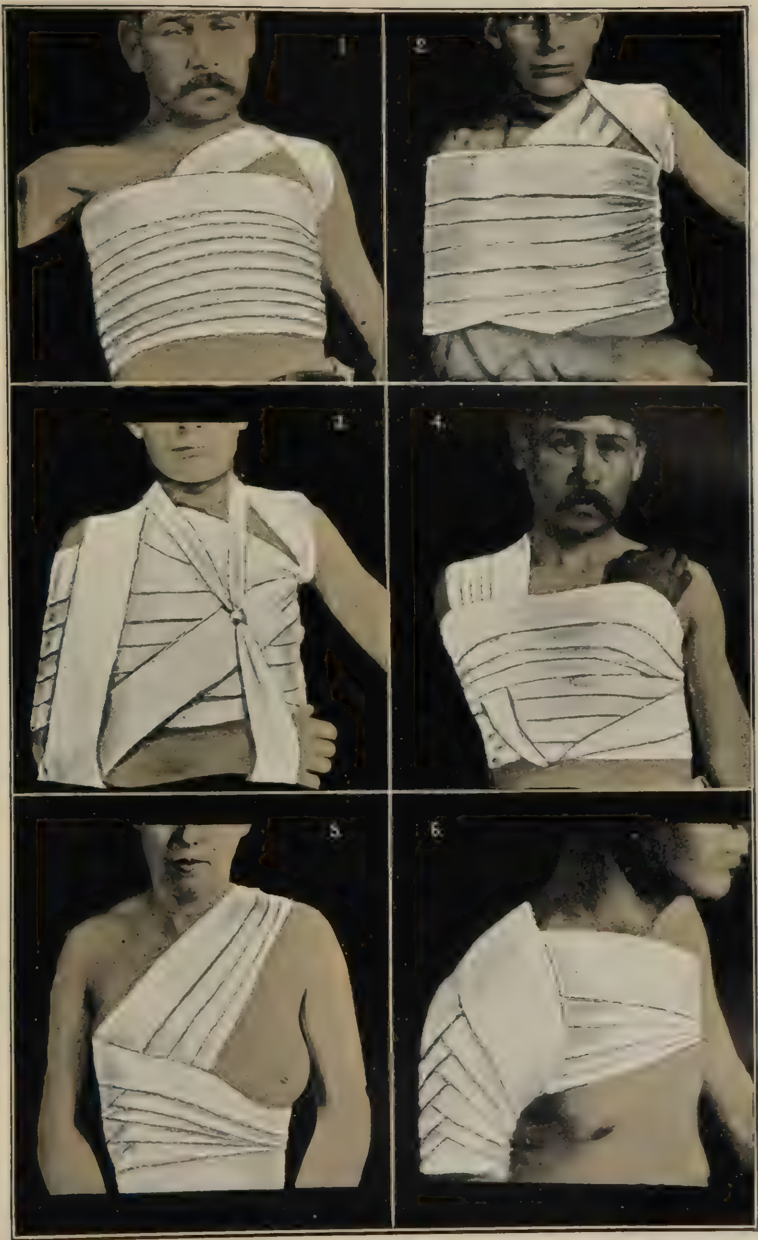
Recurrent Bandage of the Head.—Take a roller two inches wide and six yards long. Make two circular turns horizontally around the forehead and head; when the middle of the forehead is reached, catch the bandage, take a half turn, carry the bandage to the occiput, let an assistant catch it, take a half turn, bring the roller forward to the forehead, covering a portion of the preceding turn; continue this process until the scalp is well covered; terminate with two circular turns around the forehead and head (Pl. 10, Fig. 3). It is often advisable to take a turn around the head and chin. Pin the crossed pieces.

Recurrent Bandage of a Stump.—Take a roller two inches wide and six yards long. Make two light circular turns around the root of the stump; make recurrent turns covering the stump as is done in covering the head; take a circular turn around the root of the stump, oblique turns to the top of the stump, circular turns around the tip, and apply an ascending spiral reversed bandage (Pl. 11, Fig. 5).

T-Bandage of the Perineum.—Pass the transverse part around the body above the iliac crests, and pin it in front; bring one of the tails over the dressing and up between the thigh and the genitals of one side, and the other tail over the dressing and up between the thigh and the genitals of the opposite side; secure these tails to the horizontal band.

Handkerchief Bandages.—Take unbleached muslin one yard square. The muslin folded once makes an *oblong* bandage; bringing its diagonal angles together makes a *triangle* bandage; a *cravat* is formed by folding a triangle bandage from summit to base; a *cord* is a twisted cravat. The triangle makes an admirable sling.

Fixed Dressings: Plaster-of-Paris Bandage.—Cover the



1-3 Desault's Bandage: 1, First Roller; 2, Second Roller; 3, Third Roller; 4, Velpeau's Bandage; 5, Figure-of-8 Bandage of the Breast; 6, Spica of the Shoulder.

extremity with a cotton or flannel bandage or with a woollen stocking. Take a gauze roller infiltrated with plaster, and place it endwise in a basin of cold water, the water covering the plaster. When bubbles cease to come off, squeeze the bandage and apply it *without much tension*, smoothing out each turn with a moistened hand. As each bandage is taken from the basin, drop a fresh one into the water. Apply four thicknesses of bandage, and finish the dressing by sprinkling dry plaster over the bandage and smoothing it with wet hands. The ordinary plaster will set in from fifteen to thirty minutes. If it is desired to have it set more rapidly, put salt or alum in the water; if to have it set more slowly, pour stale beer into the water. The plaster bandage is removed by sawing it down the front or by moistening with dilute hydrochloric acid and then cutting through the moistened line with a strong knife.

Silicate-of-soda Dressing.—Protect the part as is done for a plaster bandage. Bandage the limb *loosely* with an ordinary muslin bandage, paint this bandage with silicate of soda, apply another bandage and paint it, and so on until six layers are applied. Gauze bandages soaked in silicate are better than ordinary bandages. Silicate dressings require from twelve to eighteen hours to dry, and they are removed by softening with water and cutting.

XXXIII. PLASTIC SURGERY.

Plastic surgery includes operations for the repair of deficiencies, for the replacement of lost parts, for the restoration of functions in parts tied down by scars, and for the correction of disfiguring projections. The following are the methods used:[1]

Displacement is the method of stretching or of sliding:

[1] *American Text-Book of Surgery.*

(1) approximation after freshening the edges (as in hare-lip; (2) sliding into position after transferring tension to other localities (linear incisions to allow of stretching of the skin after large wounds). *Interpolation* is the method of borrowing material from an adjacent or a distant region or from another person: (1) *transferring a flap with a pedicle*, which flap is put in place at once or is gradually gotten into place by a series of partial operations; (2) *transplanting without a pedicle*, which is performed by placing in position and by fixing there portions of tissue recently removed from the part, from another part of the same individual, or from a lower animal (as the button of bone after trephining, or in nerve-grafting), or by skin-grafting. *Retrenchment* is the removal of redundant material and the production of cicatricial contraction.

Skin-grafting.—In *Reverdin's method* the surface to be grafted should possess healthy granulations which are at the skin level. The grafts may come from the person to be grafted or from another person. Cleanse the skin from which the grafts are to come, the ulcer, and the skin about it, and, if corrosive sublimate is used, wash it away with a stream of warm normal salt-solution. Thrust a sewing-needle under the epidermis to lift it up, cut off the graft with a pair of scissors, and place the cut surface of the graft upon the ulcer. After applying a number of grafts place thin pieces of gutta-percha tissue over the grafts and extending on each side of the ulcer, and so placed as to allow drainage. This tissue, after being asepticized, is moistened with warm normal salt-solution ($\frac{6}{10}$ of 1 per cent.). Dress with a pad of aseptic gauze moistened with salt-solution; place over this gauze a rubber dam, and over the latter absorbent cotton and a bandage. In the case of children apply a light silicate bandage. Put the patient in bed. In forty-eight hours remove all the dressings except the gutta-

percha tissue, irrigate with normal salt-solution, and reapply the dressings. All signs of the grafts will often have disappeared. In a day or two, at the site of grafting, bluish-white spots should appear, which are islands of epidermis. Each graft is capable of forming about half an inch of cicatrix. Grafting stimulates the edges of the ulcer to cicatrize and contract. The spot from which the grafts are taken is dressed antiseptically. Reverdin's method does not limit cicatricial contraction to any great degree, and the new skin is apt to break down. At the end of seven days the special dressings can be dispensed with.

Thiersch's Method.—Thoroughly asepticize the ulcer, the surrounding skin, and the site from which the graft is to come (the inner side of the arm or the thigh), and wash away the mercurial preparation with normal salt-solution. Apply dressings wet with salt-solution. On bringing the patient into the operating-room, remove the dressings from the ulcer, scrape the ulcer and its edges, irrigate with salt-solution, and compress to arrest hemorrhage. Grafts are then obtained by putting the prepared skin upon the stretch and cutting strips with a razor. While the razor is being used the part is constantly irrigated with salt-solution. The grafts are pressed into place, and each graft overlaps a little the edges of the wound and the adjacent grafts. Mixter's apparatus enables one to perform this operation with great neatness and speed. The skin-wound is dressed antiseptically, and the grafted area is dressed as in Reverdin's method. Recently it has been suggested that a ring of aseptic gauze be made to encircle the limb below the grafted area, and another ring above the grafted area; on these pads little strips of wood wrapped in aseptic gauze are so laid as to make a cage, and around this cage the dressings are applied (moist chamber plan).

XXXIV. DISEASES AND INJURIES OF THE GENITO-URINARY ORGANS.

Hæmaturia.—By this term is meant the voiding of bloody urine or pure blood, the blood arising from any portion of the urinary apparatus, and the condition being a symptom, and not a disease. Hæmaturia may be a symptom of disease or of injury of some part of the urinary system, of blood-disorganizations (purpura, scurvy, or variola), or of metallic poisoning (mercury, lead, or arsenic). The color of the urine in hæmaturia may be anything between a light-red and a decided black, but these colors may be produced by agents other than blood. Senna and rhubarb make urine red; carbolic and salicylic acids, brown; beet-root and sorrel, the color of blood. In jaundice, melanosis, and splenic fever the urine becomes brown. Be sure that bloody urine in the female is not due to admixture with menstrual blood.

Tests for Blood.—*Spectroscope Test.*—Fresh urine diluted with water shows the two absorption bands of oxyhæmoglobin. The addition of ammonium sulphide causes the two bands to give place to the band of reduced hæmoglobin. If bloody urine stands for some time the four bands of methæmoglobin are discovered (Von Jaksch).

Heller's Test.—Add to the urine potassium hydrate, and boil: a red precipitate of earthy phosphates and hæmatin forms. Throw the precipitate upon a filter and treat with acetic acid: a red solution is produced, which soon fades.

Rosenthal's Test.—Take the precipitate from caustic potash, dry it, and test it for hæmatin; put some of the dry sediment on a slide, add a crystal of common salt, apply a cover-glass, and cause a few drops of glacial acetic acid to flow under the glass; warm, but do not boil. Teichmann's crystals will appear on cooling.

Struve's Test.—Test the urine with hydrate of potassium, and add acetic acid in excess: a dark precipitate forms, which will yield crystals of hæmatin when treated with sal ammoniac and glacial acetic acid.

Almen's Test.—Take 10 cc. of urine, and pour upon its surface a mixture of equal parts of tincture of guaiac and old oil of turpentine: at the point of junction of this fluid with the urine there forms a white ring which turns blue.

Microscope Test.—The microscope shows numerous corpuscles except in a very alkaline urine, when but few corpuscles may be found.

In hæmoglobinuria—a condition sometimes occurring in burns, acute maladies, and metallic poisoning—there is present blood coloring matter, which is shown by Heller's test and by Almen's test. The spectroscope shows methæmoglobin. The microscope shows no corpuscles or only a few, but discloses masses of pigment.

Bleeding from the Kidney-substance.—Bleeding from the *pelvis* of the kidney and from the *ureter* may be due to inflammation, congestion, contusion, stone, vicarious menstruation, hemorrhagic diathesis, powerful diuretics, fevers, purpura, tumors, catheterization of the bladder, etc. Blood is thoroughly mixed with the urine, and no sediment forms (smoky urine). The corpuscles are profoundly altered, are devoid of coloring matter, and show pale-yellow rings. The severity of the hemorrhage is measured by the number of the corpuscles. Von Jaksch states that the diagnosis between renal and ureteral hemorrhage rests on the nature of the casts and the epithelium present. From the pelvis of the kidney and from the ureter comes small epithelium, the cells from the superficial layers being polygonal or elliptical, those from the deeper layers being oval or irregular. In hemorrhage from the ureter the cells are few; in hemorrhage from the pelvis they are plentiful and rest upon one another like

"tiles on a roof" (Von Jaksch). Cells from the tubules of the kidney are small, granular, and polyhedral, have large nuclei, and are often so arranged as to form cylinders (epithelial casts). The urine of renal hemorrhage is apt to be acid unless alkalies have been administered, unless the bleeding has been severe, or unless pus is present in the urine. A very large renal hemorrhage may cause the passage of almost pure blood. In *renal* hæmaturia there are aching in the loin, numbness of the corresponding leg, and often renal colic.

Vesical hemorrhage, including hemorrhage from the prostate, may follow the relief of retention of urine, may be due to stone, inflammation, tumor, etc., or may arise from traumatisms, instrumental or otherwise. The color of the urine is usually bright-red, but if long retained in the bladder it becomes black and often tarry. The reaction is alkaline. The clots, when floated out, are large and without definite shape. In micturition the urine is clear or only a little colored at the beginning, but becomes darker and darker as micturition ends, at which time the flow may consist of almost pure blood. In very small vesical hemorrhages the urine may be smoky. Crystals of triple phosphate indicate bladder disorder. The microscope shows colorless and swollen corpuscles and many polygonal cells. Symptoms of bladder mischief usually exist, but cystoscopic examinations or exploratory suprapubic cystotomy may be demanded for the diagnosis.

Urethral Hemorrhage.—In urethral bleeding blood comes independently of micturition, or blood comes out first and is followed by pure water. Urethral hemorrhage arises from an acute urethritis, from an inflamed stricture, from the passage of an instrument, or from some other traumatism.

Pain in Genito-urinary Diseases.—Pain as a symptom of genito-urinary disease may be found at some point dis-

tant from the seat of lesion. A stone in the bladder causes pain in the head of the penis just back of the meatus; stone in the kidney induces pain in the loin, the groin, the thigh, and the testicle; inflammation of the testicle causes pain in the line of the cord in the groin. In other cases of genito-urinary disease pain is felt at the seat of lesion, as in urethritis and prostatitis. Pain felt before micturition, and being relieved by the act, is found in cystitis and in retention of urine. Pain is felt during micturition in inflammation of the bladder, prostate, and urethra and in the passage of gravel or stone. Pain which is acute at the end of micturition is noted in stone in the bladder, in inflammation of the neck of the bladder, and in inflammation of the prostate gland. The pain of stone in the bladder, it may be observed, is ameliorated by rest and is aggravated by exercise. The pain of acute prostatitis is intensified by defecation.

Frequency of Micturition.—Frequent micturition arises from irritation of the sensory nerves, from phimosis, contracted meatus, inflammations, very acid urine, calculi, urethral stricture, and hyperæsthesia of the urethra. Frequency of micturition may be due to spinal irritability from concussion or from sexual excess, from contraction of the bladder rendering the viscus unable to hold much, or from excessive urinary secretion, as in diabetes or in the first stage of contracted kidney. Frequent micturition exists in obstruction by enlarged prostate and in atony of the bladder-walls. Hypersecretion of urine plus bladder intolerance is known as "nervousness," and is found in hysteria. Frequency of micturition increased by *movement* is observed in stone and tumor of the bladder; increased by *rest*, is found in enlarged prostate and atony of the muscular walls of the viscus. Frequency of micturition with diminution of stream-calibre suggests a constriction of the urethral diameter; frequency of micturition with diminished force suggests a pos-

terior stricture, enlarged prostate, or bladder atony. Slowness of micturition hints at enlarged prostate, atony, or urethral stricture.

Thompson's diagnostic questions are as follows:

"1. Have you any, and, if so, what, frequency in passing water? Is frequency more manifest during the night or the day? Is frequency more manifest during motion or rest? Does any other circumstance affect it?

"2. Is there pain on passing urine, and, if so, is it before, during, or after the act? What is its character—acute, smarting, dull, transitory, or continuous? What is its seat? Is it felt at other times, and is it produced or intensified by sudden movements?

"3. What is the character of the stream? Is it small or large; twisted or irregular; strong or weak; continuous, remitting, or intermitting? Does it come by the meatus, or partly or entirely through fistulæ?

"4. Is the character of the urine altered? What is its appearance, color, odor, reaction, and specific gravity? Is it clear or turbid, and if turbid, is it so at the time of passing? Does it vary in quantity? Are the normal constituents increased or diminished? Does it contain abnormal elements, as albumin or sugar? What inorganic deposits are found? What organic materials are met with?

"5. Has the urine ever contained blood? If so, was the color brown or bright red; were the blood and urine thoroughly mixed; was the blood passed at the end or at the beginning of micturition, or did it come only with the last drops of urine; or was it passed independently of micturition?

"6. Inquire as to pain in the back, loins, and hips, permanent or transitory, or for the occurrence of severe paroxysms of pain there."

Mobile Kidney.—There are two forms of this condition:

(1) *Movable kidney*, a kidney freely moving back of the peritoneum, either within the cavity of its fibro-fatty capsule or entirely without its capsule (this condition is acquired); and (2) *floating* or *wandering kidney*, a kidney having a mesonephron and lying within the peritoneal cavity (this rare condition is always congenital). Keen states that there may be drawn a clear theoretical distinction between movable and floating kidney, but practically there is no rigid line of demarcation, as a movable kidney may have as large a range of movement as a floating one. When a movable kidney becomes fixed in an abnormal situation the organ is spoken of as *dislocated*. The organ may drop below the brim of the pelvis, may cross the vertebral column, or may reach the anterior abdominal wall. Women more often suffer from movable kidney than do men, and it is found in the great majority of cases upon the right side. Floating kidney is always congenital. Among the assigned causes of the movable condition are to be named traumatisms, strains, abdominal-wall laxity from pregnancy, absorption of peritoneal fat from wasting disease (Edebohls) and tight lacing.

Symptoms of Both Forms.—There may be no discomfort whatever, or the patient may be a confirmed invalid. The usual symptoms are epigastric pain (just to the left of the middle line) which disappears when the kidney is replaced, dragging pain in the loin, and paroxysms like nephritic colic. There is a sense of a moving body in the abdomen, and the patient has aggravated indigestion, often accompanied by vomiting. Constipation is the rule, and violent attacks of cardiac palpitation are common. Most subjects of this kidney-mobility are extremely nervous, many of them hysterical or hypochondriacal. In women the sexual organs are almost invariably deranged, and menstruation aggravates the pain and discomfort. All the symptoms are intensified

by exertion and are modified by rest. The urine is normal. The proof of the existence of movable kidney is the finding of a tumor (movable on respiration, change of position, and palpation) shaped like that organ, pressure upon which occasions no sensation or causes pain or a sickening feeling. A "lumbar rĕcess" (Morris) may be found, and percussion over the loin gives resonance. A movable kidney must not be mistaken for a distended gall-bladder, a tumor of the mesentery, stomach, or omentum, a phantom tumor, an ovarian tumor, or a cancer of the pancreas. Sometimes a movable kidney endangers life, rupture of the kidney or twisting or rupture of the ureter occurring, the ultimate cause of death being albuminuria, uræmia, or hydronephrosis.

Treatment.—Mobile kidney is treated as follows: (1) *The rest-treatment of Weir Mitchell* may be tried; it often markedly mitigates the symptoms, but does not seem to cure. (2) *Bandage and pad* should always be tried, using the pad of Dunning or Newman: this will cure not a few cases. Edebohls uses only a bandage of elastic webbing or a well-fitting corset. (3) *Nephrorrhaphy* is the proper procedure in most instances (p. 711). (4) *Nephrectomy* in rare cases is necessary; it may be done for dislocated kidney, when kidney disease exists, or when nephrorrhaphy has failed in a case of severity.

Injuries of the Kidney.—Laceration or **rupture** is caused by falls and by blows upon the back and the belly. The blood may or may not extravasate into surrounding structures. The *symptoms* are—pain in the loin, shooting into the testicle or the thigh; frequent and painful passage of bloody urine or suppression of urine; the loin is full and is dull on percussion, and collapse or evidences of internal hemorrhage exist. Bloody urine is not proof of renal injury, and kidney damage may occur without hæmaturia.

Treatment.—If the shock is profound with increasing ful-

ness of the loin, whether hæmaturia exists or not, or if blood comes profusely from the urethra, make an exploratory lumbar incision and, if necessary, remove the organ. Ordinarily the cases are treated by rest in bed and by feeding with liquid food or by nutritive enemata to prevent vomiting. Ergot, opium, or gallic acid may be used. Apply ice-bags to the loin and the side of the abdomen, and after bleeding ceases strap the loin and apply a binder. If large blood-clots cause pain or retention, introduce a catheter and inject the bladder with boracic acid, or use the tube and evacuator of a Bigelow apparatus. If this procedure fails, open the bladder.

Perforating wounds of the kidneys, if posterior, do not involve the peritoneum; if anterior, they do. The *symptoms* are—escape of blood and urine by the wound; hæmaturia is usual, but not invariable; pain as in rupture; the patient may be unable to micturate; and nausea, vomiting, and constitutional signs of hemorrhage exist. Traumatic peritonitis, perinephric abscess, or general sepsis may ensue. Confirm the diagnosis by exploration with the finger. Extraperitoneal injuries give a good, and intraperitoneal a bad, prognosis.

Treatment.—If the wound in perforated kidney is extraperitoneal, enlarge it to permit of drainage, and arrest hemorrhage by packing and hot water. Asepticize the wound, insert a drainage-tube down to the kidney, dress often with bichloride gauze, keep the patient in bed on a low diet, and give ergot and opium. In intraperitoneal wounds, perform an abdominal section and remove the damaged organ (see *Nephrectomy*).

Renal Calculus.—A stone in the kidney is formed by the precipitation of urinary salts into the renal epithelial cells and the gluing together of these salts and cells by material from mucus or blood-clot, this mass serving as a nucleus on which accretion takes place. Most calculi escape when

small as *gravel.* The *cause* is a highly acid urine which induces catarrh of the renal tubes. This high concentration of urine is favored by a sedentary life, by the ingestion of much alcohol or nitrogenous food, by constipation, by an inactive skin, and by a torpid liver. The children of poverty are liable to calculi because of the use of unsuitable foods and the formation of great amounts of nitrogenous waste. Males more often suffer than do females, certain locations favor the development of the malady, and a family liability sometimes exists.

Symptoms.—The symptoms of stone in the kidney may not appear for years, but usually they are manifested early. Nephritic colic is due to the washing of a calculus into the orifice of the ureter, which it blocks, tears, or distends. The pain is either sudden or gradual in onset, is fearful in intensity, and runs from the lumbar region down the corresponding thigh and spermatic cord (the testicle being retracted) and into the abdomen and shoulder-blade. There are nausea, vomiting, collapse, sometimes unconsciousness or convulsions. Frequent attempts at making water are productive of pain, but of little urine. The urine is usually, but not always, smoky from blood. After a time the pain vanishes, the stone having passed into the bladder or having fallen back into the pelvis of the kidney. A calculus retained in the kidney eventually excites pyelitis. There is pus in the urine, and soreness or pain in the loin exists. Attacks of colic occur from the passage of small stones or of plugs of mucus. Entire obstruction of the ureter induces hydronephrosis or pyonephrosis. Nephrolithiasis may cause death by exhaustion, by sepsis, by rupture of a hydronephrosis, or by amyloid degeneration.

Treatment.—In the gravel of uric-acid diathesis, use alkalies, especially the liquor potassii citratis, and reduce the amount of nitrogen in the diet to a minimum, at the

same time washing out the organs by copious draughts of Poland water or Londonderry lithia. Piperazine, in doses of grs. v to grs. viij three times a day, is highly commended. Exercise is to be insisted on. When gravel is phosphatic, order strychnine, the mineral acids, and rest at the seaside. When oxalate of lime is found, restrict diet, use the mineral acids, recommend travel or rest amid new surroundings, and give an occasional course of sodii phosphas, ʒss three times a day, drunk in Buffalo lithia water. Nephritic colic is relieved by hypodermatic injection of morphia and atropia, the hot bath, diluent drinks, or the inhalation of ether. After the attack wash out the bladder with an evacuator. If a stone impacts in the ureter, perform the operation of ureterolithotomy. The diagnosis of this impaction is often possible only by exploratory laparotomy. If the symptoms point to stone in the kidney, medical treatment having been used without avail, and there being no evidence of organic disease of the other kidney, make an exploratory lumbar incision; feel the surface of the kidney with the finger, sound the inside of the organ with a needle, and if a stone is detected remove it (see *Nephrolithotomy*, p. 709). Dr. Keen is of the opinion that operation should not be performed if the urea is below 1 per cent. If, after nephrolithotomy, suppression of urine occurs, cut into the other kidney, as in half of all cases a stone will be found lodged there.

Abscess of the kidney is caused by traumatism, by calculus, by stricture of the urethra, by disease of the bladder, by the union of miliary abscesses, or by pyæmia. The *symptoms* are pus in the urine (this is usual, but not invariable), hæmaturia in traumatic cases, and pain running into the groin. Constitutional symptoms of suppuration exist. The *treatment* in the early stage is rest, morphia, purgation, anodynes, and ice-bags to the loin, followed in forty-eight hours

by hot fomentations. When the diagnosis is clear, incise the loin, open and stitch the kidney to the abdominal wall, or, if the organ be badly damaged, remove it.

Pyelitis and **pyelonephritis**, which affect usually only one gland, are caused by urethral stricture, by stopping of the ureter by blood-clot, by vesical paralysis, by stone in the bladder or in the kidney, and by enlargement of the prostate gland.

Symptoms.—A patient who has, or who has had, retention of urine develops high fever often preceded by a chill; headache, stupor, and dry tongue are noted. Unlike acute Bright's disease, there is neither œdema nor dry skin, convulsions do not occur, and the urine is plentiful and contains pus and, but rarely, blood. The *prognosis* is very bad. The *treatment* is to remove the obstruction if possible. If the urine be acid, give liquor potassii citratis; if alkaline, give benzoic-acid. Gallic acid, eucalyptol, and small doses of copaiba or cubebs are recommended. Quinine is used to stimulate the patient and to lower fever. The bladder is to be washed out every day with boracic-acid solution (gr. iij to ℥j). Cups, dry or moist, and hot sand-bags or bran-bags are to be applied to the loin. Alcohol may be sparingly administered.

Perinephritis.—The *symptoms* of this condition are rigidity of the spine, the inclination being toward the affected side, flexion of the foot, and often pain in the knee. The symptoms resemble those of hip-joint disease in the second stage. Suppuration may or may not take place. The *treatment* is wet cups to the loin, ice-bags to the loin, rest, purgation by salines, morphia for pain, and, after the acute stage, potassium iodide internally and ichthyol locally.

Perinephric Abscesses.—*Primary abscess* is caused by chills, traumatism, acute febrile disturbances, or by pus flowing from some other part, as the spine. *Consecutive abscess* is secondary to kidney inflammation, suppuration, calculus,

tuberculosis, or cyst. In the consecutive form the symptoms may be masked by the malady to which perinephric abscess is secondary. As a rule, in perinephric abscess there are found the constitutional symptoms of suppuration. The local symptoms are a deep aching and paroxysmal pain intensified by lumbar pressure. Œdema of the corresponding foot and lameness are not unusual. Œdema of the skin is usual, but fluctuation is rare. The exploratory incision will settle a doubtful diagnosis. The *treatment* is to lay open the abscess, wash it out, and drain.

Hydronephrosis is a condition of the kidney in which an impediment to the outflow of urine is caused by obstruction in the ureter, the bladder, or the urethra, the calyces of the kidney becoming over-distended with urine and the glandular tissue being absorbed by pressure. This condition may be congenital, and is due usually to twisting of the ureter or to imperforate meatus, both kidneys being involved. The *causes* of the acquired form are the pressure of pelvic growths or pregnancy, inflammation or tumor of the bladder, stone in the bladder, kidney, or ureter, twisting of the ureter of a movable kidney, enlargement of the prostate gland, and stricture of the urethra. This acquired hydronephrosis may involve both kidneys, all of one kidney, or only a part of a single gland.

Symptoms and Treatment.—Hydronephrosis is most frequent in females. When tumor is absent there may be no symptoms, or there may be pain in the back and abdomen, frequent micturition, a persistent or intermittent diminution in urine, or even occasional anuria. A tumor may be found in the loin, which growth is dull on percussion and may come and go, a large urinary flow being noted when it disappears. Hydronephrosis may last a long while if only one kidney be involved, but death is not far distant if both glands suffer. Death occurs from anæmia, from pressure on

adjacent organs, or from rupture into the peritoneal cavity. *Treatment* by aspiration may cure, but the operation may have to be done repeatedly. Tapping on the left side is performed just below the last intercostal space; on the right side the tap is made midway between the last rib and the crest of the ilium. If repeated aspirations fail, perform a nephrotomy, stitching the edges of the cut kidney to the surface and irrigating. If a permanent suppurating fistula ensues or if the organ is found extensively damaged, nephrectomy is to be performed, provided the other kidney is in reasonably good condition.

Pyonephrosis, or **surgical kidney,** is a condition in which the pelvis and the calyces of the kidney are distended with pus or with pus and urine. The whole kidney may be destroyed. This condition has the same causes as has hydronephrosis, for it is in reality usually an infected hydronephrosis. In some cases the inaugural malady is pyelitis which causes blocking of a ureter.

Symptoms and Treatment.—At first the symptoms are those due to the obstructing cause, plus pyelitis. Pus may appear in the urine in incomplete obstruction, or it may intermittently come and go. Constitutional symptoms of suppuration are soon manifest. A tumor may appear in the loin, like the tumor of hydronephrosis. If only one kidney be involved, and if the disease is due to blocking of a ureter, recovery is to be expected. The *treatment* in the early stages comprises removal, if possible, of the cause of obstruction and the employment of measures directed to the cure of the pyelitis. If obstruction is not complete, palliative measures may be employed for the tumor. If fever is continued, if there is great visceral derangement, if pain is severe and constant, and if the tumor continually grows, perform a nephrotomy, stitching the organ to the surface if possible, or removing it if it is hopelessly disorganized.

Operations on the Kidney.—*Nephrotomy* means incision of a kidney, but the term is also applied to the exploratory exposure of the kidney without incision. The *instruments* required are scalpels, a blunt-pointed bistoury, dissecting-forceps, toothed forceps, a grooved director, hæmostatic forceps, spatulæ, metal retractors, a fountain syringe, an Allis dissector, Hagedorn needles, and an Abbé needle-holder. If looking for a stone, have a large hare-lip pin to sound with, forceps and a scoop to remove the stone, and a periosteum-elevator to scrape away adherent calculi. The patient lies upon the sound side, a sand pillow being placed under the loin. The *incision* is made half an inch below the last rib and close to the outer border of the erector spinæ mass, and runs obliquely downward and forward toward the iliac crest for three inches, the incision being enlarged later if required. Divide the skin, the superficial fascia, the fat, the external oblique, the posterior border of the external oblique, and the outer edge of the latissimus dorsi. This incision exposes the lumbar fascia. Push aside the last dorsal nerve and incise the lumbar fascia, when the perirenal fat will bulge into the wound. Two distinct layers of fat exist. Tear this fat through with dissecting-forceps or with an Allis dissector to expose the kidney, which can now be opened while it is forced into the wound by the hand of an assistant making abdominal pressure.

Nephrolithotomy.—In this operation the incision is the same as in nephrotomy. Feel the kidney for a stone, or, if this procedure fails, explore with a needle or a pin. Morris suggests that first the organ be well drawn out. If no stone be found, open the pelvis and explore with the finger. If a stone be detected, open the kidney-tissue, loosen the calculus with the nail, and remove it with the finger, with a scoop, or with forceps. After removing the stone, stop renal hemorrhage by pressure and hot water, or in some cases

plug with iodoform gauze for twenty-four hours. When hemorrhage ceases put a large drainage-tube down to the kidney. Close the wound in the muscles and integument, and dress antiseptically. The dressings must be changed frequently and the tube should be shortened daily.

Nephrectomy is the removal of a kidney. The mortality for cancer is 10 per cent., for tubercle 36 per cent. There are two methods of nephrectomy, the *lumbar* and the *abdominal.*

Lumbar Nephrectomy.—The instruments required for this operation are scalpels, a blunt-pointed bistoury, forceps as used in the preceding operation, a clamp, retractors, spatulæ, blunt hooks, an aneurysm-needle, a pedicle-needle, a grooved director, stout silk, an Allis dissector, sharp spoons, and a Pacquelin cautery. The position of the patient and the incision are the same as those for the preceding operation. When the kidney is exposed the incision, if necessary, may be enlarged in its existing directions, or, as Morris advises, it may be enlarged by cutting with a blunt bistoury a vertical incision from a point one inch in front of the posterior extremity of the first cut downward and from within outward. Lift the kidney, and separate it, if possible, with the finger; clamp the pedicle; pass an armed aneurysm-needle between the vessels of the pedicle; ligate in two places; cut between the threads; and arrest hemorrhage by ligature or by the cautery. If the ureter be healthy, drop it back; if it be foul and purulent, scrape it with a spoon, wash it with corrosive sublimate, and touch it with pure carbolic acid, and then either drop it back or sew it into the wound. If hemorrhage persists from the wound, plug. Put in a drainage-tube and close the wound. If the peritoneum be accidentally opened, close it with Lembert's suture.

Abdominal nephrectomy is more dangerous than the lumbar operation. The same instruments are required as

are used in the preceding operation. The position is supine. The incision is that of Langenbeck—four inches long in the linea semilunaris, its centre corresponding to the umbilicus. Open the abdomen, introduce a hand, feel the kidneys, and if both show serious disease do not perform nephrectomy. Keep the small intestines away by sponges, push the colon toward the umbilicus, incise the outer layer of the meso-colon, and bare the kidney. Strip off the peritoneum from the kidney and its vessels, and ligate the vessels by passing strong silk through the centre of the pedicle with an aneurysm-needle. Ligate the ureter if healthy, and cut. If the ureter is septic, fasten it to an opening made in the loin by cutting on to forceps pushed to the outer edge of the quadratus lumborum. Stop bleeding, irrigate the belly-cavity, and dress as usual, employing drainage only when septic matter has gotten into the peritoneal cavity or when oozing is persistent.

Nephrorrhaphy is fixation of a mobile kidney. The kidney is exposed in the loin as above detailed, and is forced into the wound by abdominal pressure. Insert sutures of chromicized gut, kangaroo tendon, or silkworm gut, by means of curved Hagedorn needles, through the renal substance, and thus fix the organ to the lumbar fascia. Use drainage-tubes until inflammation appears. The mortality is about 3 per cent.

Retention of Urine.—By this term is meant an inability to empty the bladder. The retention may be *complete*, not a drop emerging, or it may have been complete, a dribbling setting in after a time, due to paralysis of the bladder, which cannot contain more fluid, expulsion of the overflow from the ureters being produced by atmospheric pressure. This condition is known as *the engorgement, the overflow*, or *the incontinence of retention.* There may be a *partial* retention from enlarged prostate, a portion only of the urine being

voided. Retention may be caused by—(1) *obstruction*, resulting from urethral stricture, enlarged prostate, inflamed prostate, occluded meatus, impacted calculus, urethral tumors, complete phimosis, fecal impaction, and pressure from gravid tumors, or by (2) *defective expulsion*, resulting from paralysis, disease or injury, atony, reflex inhibition, shock, muscular weakness of fevers, and the action of drugs such as belladonna, opium, or cantharides.

Symptoms.—In acute retention there is an agony of desire to urinate, the patient making acutely painful straining efforts during which feces are often passed. There are severe pain and aching in the abdomen, thighs, perineum, and penis. All the symptoms rapidly increase, a typhoid state is inaugurated, and death closes the drama unless relief be given. If retention is from time to time alleviated by the passage of a little water, the symptoms are slower in evolution and are less intense, and the case is said to be chronic. Some cases of gradual onset, due to atony, are very insidious, the patient feeling no particular pain, and complaining only of the dribbling, which is really the overflow of retention, and is not a sign that the bladder is successfully emptying itself. In any case of retention the bladder rises above the pubes, and there is found a pyriform, elastic, fluctuating tumor (dull on percussion) in the hypogastrium, which tumor enlarges until the bladder is evacuated or incontinence sets in. The flanks of the patient give a clear percussion note, and the tumor is more prominent when he is erect than when recumbent. Long continuation of obstructive disease, producing partial retention with or without attacks of complete retention, disorganizes the kidneys. Acute and complete retention may induce rupture of the urethra or urinary suppression.

Treatment.—In *organic stricture* try to pass a soft catheter; if this fails, a hard catheter; if this fails, a filiform bougie; but if the stricture is known to be organic from previous

history, at once insert a filiform bougie, leave it in place, and fasten it. The filiform bougie will act as a capillary drain, and in a few hours will empty the bladder. Then insert another bougie beside the first, and so on for several days, using also opium, ordering rest in bed, and making no attempt to dilate the stricture forcibly until retention is passed and inflammation has subsided. If no bougie can be passed, aspirate or perform cystotomy (suprapubic or perineal). In *spasmodic stricture* hold a good-sized metal catheter firmly against the face of the spasmed area: relaxation will occur and the instrument will eventually pass. In *inflammations* give a hot hip-bath and suppositories of opium and belladonna, and then use a hot sand-bag to the perineum and hot poultices to the hypogastrium. If these fail or if the symptoms are urgent, pass a soft catheter. In the *occluded meatus of the new-born* incise with a tenotome. In a *congenital cyst of the sinus pocularis* pass a steel bougie, which will rupture the cyst. In *complete phimosis* split up the prepuce. In *impacted stone* try to pull it out with urethral forceps; if this fails, push it in or cut. In *fecal impaction* scrape out with a spoon. In *enlarged prostate* insert a Coudé catheter strengthened by the insertion of a filiform bougie nearly to the beak (Brinton), or pass a silver instrument with a large curve. In *retention from expulsive defect* use a soft catheter. Cases of retention require warmth, confinement to bed, the administration of laxatives, free action of the skin, and the use of such drugs as salol, boracic acid, and quinine to asepticize the urine. In some few cases no instrument can be inserted in the bladder. In most of such cases aspirate—which may be done several times if necessary—and in a day or two, when swelling and congestion abate, an instrument can be passed. A small trocar or an aspirator-needle is pushed into the bladder, the trocar or needle being inserted in the median line, just above the pubes, and taking

a course downward and backward. The parts are first prepared antiseptically, and the puncture is dressed with iodoform and collodion. Rectal puncture is now obsolete. The perineal incision is not advocated for retention unless rupture of the urethra has taken place. When a catheter is used for retention the patient must be recumbent to minimize shock. Withdraw only half the urine retained, as complete emptying of an over-distended bladder, by suddenly relieving pressure, renders the sufferer liable to venous rupture and to severe hemorrhage. The same rule maintains in tapping.

Injuries of the Bladder.—This viscus is so deeply situated, and the abdominal walls are so elastic, that it is rarely injured when empty. If the bladder be full and the abdomen be tense—which is common in alcoholic intoxication—force applied upon the abdomen may contuse the bladder.

Contusion of the Bladder.—In this condition there are noted vesical hæmaturia, tenesmus, an impediment to the flow of water because of clots, and severe cystitis. Hemorrhage may be very severe, and sepsis may arise, even causing death. When contusion exists retention is relieved by a clean soft catheter; if this fails because of occlusion of the eye of the catheter with blood-clot, there must, from time to time, be forced through the catheter by an irrigator a solution of sodium bicarbonate in cooled boiled water. Gross's blood catheter can be used, or the evacuator of Bigelow may be employed. The patient is put to bed, a hot-water bag is applied to the hypogastrium, morphia is administered in moderate doses, the bladder is washed out several times a day with boracic-acid solution to disintegrate and remove blood-clots, and the urine is diluted and rendered aseptic by the stomach administration of salol, boracic acid, and liquor potassii citratis. Hemorrhage usually ceases on relieving distention; if it does not, some more radical measure must be employed (see *Hæmaturia*).

Besides contusions, the bladder may be injured by bullets; by stabs or punctures through the abdomen, the vagina, or the uterus; or by penetration by a fragment of a fractured pelvic bone. The symptoms of such conditions are those of rupture of the bladder (*q. v.*). In any intraperitoneal wound, at once open the abdomen, suture the wound in the bladder-wall, irrigate the peritoneal cavity, and drain the bladder by means of a retained catheter, a perineal section, or a suprapubic cystotomy. In an extraperitoneal wound, drain the wound by a tube, and drain the bladder by a retained catheter, a perineal section, or a suprapubic opening.

Rupture of the bladder occurs in three forms: (1) intraperitoneal—a rupture involving the peritoneal coat; (2) extraperitoneal—a rupture of a portion of the bladder not covered by peritoneum; and (3) subperitoneal—a rupture of the mucous and muscular coats, the urine diffusing under the peritoneal investment. The *causes* are of two kinds, predisposing and exciting. *Predisposing* causes are—distention of bladder; drunkenness; ulceration; degeneration or atony of the bladder-coats. *Exciting* causes are—obstruction to outflow of urine (by stricture or enlarged prostate); external violence; falls upon the feet and the buttocks, as well as upon the abdomen; lifting; straining at stool, in micturition, or during parturition; and the forcing of injections into the bladder. This accident is commoner in men than in women (10 to 1), and is rare in children.

Symptoms, Diagnosis, and Treatment.—The symptoms are not always definite, and every characteristic one may be for a time absent, the patient seeming in some rare instances to possess the power of retaining his urine and of voiding it. As a rule, however, there are found some or all of the following symptoms, following an accident or occurring during the progress of a causative disease: collapse; excessive desire to urinate; inability to do so; a catheter, when used, brings

away pure blood or a very little bloody urine; the catheter occasionally slips through the tear into a cavity, and more bloody water comes away; severe hypogastric pain comes on after a temporary sense of relief from retention; shock is so severe that death may ensue; if reaction follows, there is delirium, often septicæmia and peritonitis; extensive infiltrations of urine may occur. In *intraperitoneal rupture* general peritonitis is certain to arise, but its appearance may be postponed for several days if the urine is healthy. In these cases the extravasation is noted as a simple swelling, probably on one side only. In *extraperitoneal rupture* the urine may infiltrate the perineum, the scrotum, the thighs, and under the integuments of the abdomen and the back, and may soon induce sloughing. In *subperitoneal rupture* peritonitis is apt to arise. Injecting fluid fails to lift up the bladder into the hypogastric region so as to be recognizable on percussion. If there is injected a measured amount of fluid, less will run out than went in.

In all doubtful cases take a Davidson syringe, tie a piece of cotton over its outer end, fasten its other end to a soft catheter which is inserted into the bladder, and pump in air filtered to prevent infection: an unruptured bladder will rise above the pubes as a pyriform tumor, tympanitic on percussion; a ruptured bladder will not so rise. In intraperitoneal rupture the general peritoneal cavity will be distended with the air. In extraperitoneal rupture injection produces emphysema of the extravesical connective tissues. On removing the syringe the air rushes out again if the bladder is unruptured, but little if any comes away if it is ruptured. Senn recommends injecting hydrogen gas instead of air. The *treatment* is the same as that for wounds of the bladder.

Atony of the bladder is a condition in which the expulsive power of the bladder is diminished or lost because of impairment of muscular tone. The bladder is very thin,

and the muscles are flaccid and often the seat of fatty degeneration. Sometimes the bladder is very large and sometimes it is very small. A slight degree of atony is physiological after middle age. The *causes* are senility, distention from true paralysis, chronic over-distention from obstruction, and acute over-distention.

Symptoms and Treatment.—In atony of the bladder the patient passes water frequently (a symptom probably existing for some years), and especially at night; he may even do so while asleep. The stream, when voluntarily passed, has no projection, but drops at once from the end of the penis. Retention is apt to occur with incontinence, and residual urine exists for years, and may at any time set up cystitis. This condition is *not* vesical paralysis resulting from a lesion of the nervous system. In treating atony of the bladder, measure the residual urine: if it amounts to four ounces, use a soft catheter night and morning; if it amounts to six ounces, use the catheter every eight hours; if it amounts to eight ounces, use the catheter every six hours (J. W. White). The patient should be taught how to use the catheter. After using it, it is washed with soap and water, a stream of water is run through it, it is soaked in a 1 : 1000 solution of corrosive sublimate, is kept until again wanted in a 1 : 40 carbolic solution, and when again needed is anointed with glycerin. The bladder is from time to time washed out with gr. iij to the ounce of boracic-acid solution at a temperature of 100° F. Strychnine, electricity, ergot, and cantharides may be ordered.

Vesical Calculus, or Stone in the Bladder.—The salts normally in solution in the urine may deposit as calculi and may be imprisoned in any portion of the urinary tract. The commonest calculi are those composed of uric acid, urates, calcium oxalate, and fusible phosphates. The formation of uric-acid and urate calculi is explained under Renal Calculus (p. 703). Vesical calculi are usually renal calculi that

have passed the ureter and become enlarged by new accretions. Phosphatic calculi may be formed in the bladder when chronic cystitis causes and maintains an alkaline urine. Uric-acid calculi are smooth, round or oval, and hard, but easily broken. On section they present the color of brick-dust and are marked by concentric rings. Their nuclei are dark by comparison. They are soluble in dilute potassium hydrate, and with effervescence in nitric acid. They are combustible, and leave scarcely any ash. Urate of sodium and urate of ammonium often occur together in stones, and these calculi are not in rings, are not so hard as the uric-acid stones, and are fawn-colored on section. Oxalate-of-lime stones are round with many projecting nodes like the mulberry, hence the term "mulberry calculus." They are very hard, and section shows the color to be brown or green, and that they possess wavy concentric rings. This form of calculus is soluble in hydrochloric acid. Fusible calculus, which is composed of magnesic ammonic phosphate with phosphate of lime, constitutes the commonest form of phosphatic stones and of large stones. It is light, soft, smooth, and white, and shows no laminæ on section. Some rare forms of stone are composed of xanthic oxide, cystic oxide, calcium phosphate or carbonate, and magnesic ammonic phosphate (triple phosphate).

A stone may be formed having layers of different subtances; for instance, there is often found a uric-acid nucleus surrounded by phosphates, the latter surrounded by uric acid or urates, and these again by phosphates. In some cases oxalate of lime alternates with uric acid, urates, or phosphates (Bowlby). Bowlby states that the alternating uric-acid and phosphatic layers are due to the altering reactions of the urine; that when the urine is acid, uric acid is deposited on the stone, but when cystitis makes the urine alkaline the stone receives a phosphatic coat.

Anything that favors the formation of an excessive urinary deposit may cause vesical calculus, such as defective digestion, failure in processes of oxidation, excess of solids and nitrogenous elements in the diet, deficient exercise, etc. If to the urinary condition established by the above conditions a catarrh of the genito-urinary tract occurs, pus or muco-pus in concentrated urine may induce stone. Children are predisposed to uric-acid stones, and old people to phosphatic stones. In an old man with enlarged prostate and chronic cystitis a stone forms easily about any accidental nucleus. The nucleus may be some phosphate-crystals glued up by mucus, may be a blood-clot, some uric-acid gravel, or some foreign body. Stone is rare in females, because of the shortness, the large diameter, and the ready dilatability of the urethra. Stone is very rare in the negro. Gout, rheumatism, lithæmia, enlarged prostate, vesical atony, urethral stricture, and catarrhal inflammation of the kidney, the ureter, and the bladder, are predisposing causes.

Symptoms.—In not a few cases the vesical symptoms are antedated by an attack of nephritic colic. The severity of the symptoms depends more on the roughness of the stone than on its size. Small rough calculus will produce intolerable anguish, whereas several large smooth stones will cause but moderate pain. A patient with stone in the bladder complains of frequency of micturition, particularly in the day-time, the desire being sudden, uncontrollable, and invoked or aggravated by exercise. This symptom is more positive in youth than in old age. Pain of a sharp, burning character is experienced at the end of micturition, due to the contraction of the empty bladder upon the stone. The usual seat of this pain is the under surface of the head of the penis, a little behind the meatus, and the pain may continue for some time. By pulling on the penis to relieve this pain the prepuce often becomes pendulous. This pain varies in

severity, being worse during cystitis and after exercise; it may be absent in encysted stone, it may even almost disappear, and it is always worse in the young than in the old. Stone in chronic cases of atony and in cases of vesical paralysis causes neither marked pain nor frequency of micturition.[1] Attacks of cystitis in a man with calculus are spoken of as attacks of stone. When a stone is small it may during micturition roll into the urethral orifice, and so cause a sudden interruption of the flow of water, the stream again starting when the patient changes his position. This symptom is rare in the old, the stone in them dropping into the sac back of the prostate and *below* the urethral orifice. Hæmaturia may or may not be noted; it is most usual after exercise, and is noted at the end of the urinary act. Pus or muco-pus will be noted if cystitis occurs. Priapism occurs in some cases. Pain of a reflex nature may be felt in the rectum, in the perineum, or in some distant part.

The above symptoms, even if all are present, do not prove the individual to have a stone in the bladder. To prove the presence of a stone, it must be touched with a sound and the contact must be felt and heard. To sound a patient, have the bladder well filled with water, and place him recumbent with the knees drawn up. Never sound a person while he is standing, because of the danger of syncope. In an ordinary case use a sound with a very slight curve; in a man with hypertrophied prostate use a sound with a short and decided curve. The calibre of a stone-sound is a No. 13 French. Examine the entire bladder systematically, and never operate unless a stone be both heard and felt. The stone may be hard to find, or it may elude the instrument entirely when it is encysted, when it rests in a diverticulum, when it is fixed to the roof or anterior wall of the viscus, or when it is crusted with lymph or blood-clot. In doubtful

[1] *American Text-Book of Surgery.*

cases always insist on a second examination, giving ether if the first was very painful. Occasionally a small stone will be found by using a Bigelow evacuator, the current causing the calculus to knock against the tube. A stone, when it is detected, should always be measured by an arrangement like a lithotrite. The composition of the stone is assumed from an examination of fragments which pass by the urethra or which adhere to the measure. Remember that the outer rind of a calculus may be soft phosphate and the inner portion may be hard uric acid, urates, or oxalates. Examine for stone in females with a straight sound, and in cases of uncertainty dilate the urethra and explore the bladder with the little finger.

Treatment.—In people predisposed to stone (for instance, by lithæmia) the surgeon should foresee the danger and essay to antagonize it. Insist on the urine being kept dilute by the freest use of water and of milk, and reduce to a minimum alcohol, meat, sugar, and fat. Let the patient live on green vegetables, salads, bread, fruit, eggs, fish, poultry, weak tea or coffee, water, milk, and, if desired, a little red wine. Continued purging does harm by concentrating the urine, though a laxative may be employed when indicated. Moderate open-air exercise is of immense importance, sunshine and fresh air being Nature's correctives for a condition of imperfect oxidation power. If the urine be very acid, use piperazine, grs. xv to grs. xxiv daily, liquor potassii citratis, phosphate of sodium, or borocitrate of magnesium. If the urine be phosphatic, order mineral acids and strychnine. If the urine be filled with oxalate, use the mineral acids with an occasional course of phosphate of sodium. Travel and rest at the seaside or at some spa are often of service in all forms. Always endeavor to prevent cystitis, and treat it at once when it does occur. When a stone is once formed, it is an idle dream to think of dissolving it. An operation must be done. The

operation selected depends upon the age, the state of the bladder and the prostate, the dilatability of the urethra, the kidney condition, and the size and composition of the stone (see *Operations on the Bladder*).

Cystitis.—Inflammation of the bladder is, as a rule, a complication of some other disease of the genito-urinary tract, but it can arise from cold and wet. Traumatism from a catheter, the presence of a stone, the spread of a urethral inflammation, pus infection, the existence of tuberculosis or cancer, and the use of such a drug as cantharides, can produce it. It appears not unusually during an exanthematous fever or in conditions of vesical paralysis; it often follows retention, frequently accompanies enlarged prostate and urethral stricture, and sometimes arises from concentration of urine or accompanies growths. Acute cystitis causes discoloration and swelling of the bladder-walls, and there is present a catarrhal discharge which is mixed with urinary elements, serum, mucus, often pus and epithelial débris. Ulceration, sloughing, or false-membrane formation may occur.

In chronic cystitis there is an enormous production of thick, sticky mucus and the urine becomes alkaline. The excessive secretion of mucus and the great number of bacteria convert the urea into carbonate of ammonia, and this production, being irritant to the bladder-walls, makes the inflammation worse. In chronic cystitis the bladder is contracted and has very thick walls, and the mucous membrane is thick, œdematous, congested, and filled with large veins. The bladder may be ulcerated or be encrusted with urinary salt. The urine contains triple phosphate, pus, blood, and mucus, the blood emerging with the last drops of water.

Symptoms of Acute Cystitis.—Great frequency of micturition, with the passage at each act of very small quantities of urine; the desire to urinate is almost constant, and there is intensely painful straining (tenesmus). The pain is acute

and scalding, and may be felt above the pubes or in the perineum; the pain often runs into the loins and the thighs and radiates over the sacrum. Pain above the pubes indicates involvement of the fundus, and pain in the perineum and the head of the penis points to inflammation of the bladder-neck. The urine, at first clear, loses its transparency, becomes full of thick mucus, and often contains a little blood or pus. The patient not unusually has some fever. A rectal examination causes fearful pain. If ischuria takes place there will be a chill and high fever, and anæmia may appear or vesical rupture may ensue.

Treatment.—In treating acute cystitis, try to remove the cause. If cystitis arises from the administration of cantharides, put the patient in bed and give him liquor potassii citratis. If it comes from the use of a clean sound, order rest in bed, suppositories of opium and belladonna, diluent drinks, and the use of ammonii benzoas or of lupulin. If the inflammation is septic (as from the use of a dirty sound) or is very acute, put the patient in bed, keep him warm, and use a hot sand-bag to the perineum and hot fomentations or poultices to the hypogastrium. Hot hip-baths may be used. The hips had best be elevated and the bowels be emptied by salines and glycerin enemata. An exclusive milk diet is desirable. The patient should drink copiously of sweetened water containing a few drops of aromatic sulphuric acid or of milk of almonds. An excellent remedy is the combination of equal parts of the infusion of herba herniariæ and chenopodium ambrosioides, three glassfuls, sweetened with sugar, being given every day (Von Zeissl). If the pain and straining still continue, order—

℞. Ext. sem. hyoscyamin.,	grs. viij;
Ext. cannabis indicæ,	grs. viij;
Sacchar. alba,	grs. xlviij.—M.

Div. in pulv. No. xx.

Sig. One powder every three hours. (Von Zeissl.)

Or,

℞. Camphora,	grs. viij;
Ext. cannabis indicæ,	grs. viij;
Sacchar. alba,	grs. xlviij.—M.
Div. in pulv. No. xx.	
Sig. One powder every three hours.	(Von Zeissl.)

Suppositories of extract of belladonna are of great value. If these remedies fail, the surgeon will be driven to opium, which, unfortunately constipates; when it is used, secure evacuations by glycerin suppositories or by enemata. Give a suppository containing gr. j of powdered opium and gr. $\frac{1}{6}$ of the extract of belladonna every three or four hours. Hypodermatic injections of morphia may be required. If retention occurs, use a soft catheter. If much blood is passed, give internally the tinctura ferri chloridi and blister the perineum. A very acute cystitis is rarely arrested within a week or ten days.

Symptoms of Chronic Cystitis.—This condition may be a legacy from acute cystitis, or it may appear without any acute precursory phenomena. There will be found frequency of micturition, but not so great as in the acute form; there will be slight tenesmus, and moderate pain from time to time, running toward the head of the penis. Constitutional symptoms arise only when kidney-damage has become pronounced or sepsis has occurred from absorption. The urine is ammoniacal, fetid, and turbid; it is filled with viscid, tenacious mucus or with muco-pus; it contains a great excess of phosphates, and occasionally clots of blood. This condition of chronic cystitis with the production of immense quantities of thick mucus is often called "chronic catarrh of the bladder." This state of the bladder may eventuate in the formation of stone or in the production of serious diseases of the bladder, the ureters, and the kidneys. It often occasions retention.

Treatment.—In treating chronic cystitis, remove the cause if possible, get rid of a stone, frequently evacuate residual urine, dilate a stricture, and remove a tumor. For chronic cystitis there are used certain remedies by the mouth. Water is drunk in large amounts, also iron spring-water (Marienbad, etc.). Salol and boracic acid, gr. v of each four times a day, are very valuable. Salol in fluid extract of triticum repens does good; so does chlorate of potassium, gr. x daily. Astringents such as alum, tannic acid, and uvæ-ursi leaves arrest mucus-formation. Copaiba, cubebs, buchu, uva ursi, and turpentine have all been recommended. Whatever remedy is used, see that the bladder is emptied of residual urine, using a soft instrument several times a day. Champagne and beer must be avoided in chronic cystitis. If the above plan fails, irrigate the bladder daily with peroxide of hydrogen (25 to 40 per cent. solution), nitrate of silver (2 per cent.), boric acid (5 to 10 per cent.), carbolic acid (1 : 500), corrosive sublimate (from 1 : 5000 to 1 : 20,000), or permanganate of potassium (1 to 4 per cent.). If silver or permanganate of potassium is used, first rinse out the bladder with distilled water. If any other agent is used, first wash out the bladder with boiled water. Some surgeons occasionally use, at intervals of a number of days, strong silver solutions (30 or 40 grains to the ounce). If this solution is used, after the drug runs out, wash out the bladder with a solution of common salt. The bladder is washed out by attaching to a soft catheter a tube which is connected with a graduated bottle, the force being obtained by elevating the reservoir (fountain irrigation). If these methods fail and the patient's health is breaking down, drain by perineal or suprapubic cystotomy (see *Perineal Section*, p. 736) and wash the bladder through the incision frequently and thoroughly.

Tumors of the Bladder.—These tumors may be either innocent or malignant, the latter being the commonest.

Innocent tumors are papillomata or villous tumors, mucous polypi, and fibrous polypi; malignant tumors are sarcoma (rare) and carcinoma (encephaloid, rare, epithelioma, common).

Symptoms and Treatment.—The innocent tumors rarely cause cystitis or irritation, though by obstructing the ureters or the urethra they may induce disease of the kidneys. Often hemorrhage is the only phenomenon produced by a papilloma or a mucous polyp. Malignant tumors cause cystitis, and the urine contains mucus, blood, and pus. Innocent tumors are hard to feel with the sound, but malignant tumors are easily felt. The bleeding in bladder-growths is apt to be profuse, and it occurs intermittently. Bleeding follows the use of a sound. The urine should be examined microscopically to see if it contains villi, portions of fibroma, colonies of cancer-cells, or fragments of epithelioma (White). The use of Leiter's cystoscope may aid the surgeon, but it is scarcely yet a perfected instrument. In doubtful cases exploratory suprapubic cystotomy is advisable. The *treatment* is by suprapubic cystotomy and removal of the growth. The perineal operation only enables the surgeon to reach and remove growths of small size, pedunculated growths, and growths near the neck of the bladder (see *Operations on the Bladder*).

Operations on the Bladder: Lateral Lithotomy.—*Lithotomy* is the removal of a stone from the bladder. *Lateral lithotomy* is an operation which is every year becoming less popular, but which is still employed by many famous surgeons, especially for stone in children. This operation should not be performed if the stone is over two inches in its short diameter; it is rarely justifiable if the stone weighs three ounces or over (Cage); and it must not be performed for encysted stone, or on a person with a deep perineum, a narrow pelvic outlet, or an enlarged prostate. For one week before

the operation keep the patient in bed, wash out the bladder daily with hot boracic-acid solution, and administer salol and boracic acid by the mouth, gr. v of each four times a day. The night before the operation, give a saline, order a hot bath, and have the perineum, the scrotum, the buttocks, and the inner sides of the thighs cleansed and dressed antiseptically. In the morning an enema is to be given. At the time of operation the bladder should contain some ounces of urine. The instruments required are a lithotomy-knife, a straight probe-pointed bistoury, a grooved staff, a stone-sound, scoops and stone-forceps, a tenaculum, an aneurysm-needle, a fountain syringe, curved needles and a needle-holder, hæmostatic forceps, a tube with chemise (Fig. 41), a Pacquelin cautery, a Clover crutch, and a lithotrite.

In performing the *operation*, place the patient upon his back and find the stone by sounding. If the stone is not discovered by the sound, *do not operate*. Pull the buttocks over the end of the table, introduce the staff, flex the legs and thighs, and fasten the patient in the lithotomy position with a crutch. During the first incision the handle of the staff is held toward the belly; after the first cut the staff is set perpendicularly and is hooked up under the pubes. An incision is made, starting just to the left of the raphé and one and a quarter inches in front of the edge of the anus, and passing downward and outward to between the anus and the ischial tuberosity, but one-third nearer the former than the latter. In the adult this incision is three inches long. The first incision is superficial and does not reach the staff, but it is this incision which may cut the rectum. After making the first cut the nail of the left index finger feels for the groove of the staff, the staff is hooked up, the knife is entered into the groove and is pushed into the bladder, and as it is withdrawn the wound is enlarged. As the knife enters the bladder there is a gush of fluid. The finger

follows the knife and stretches the wound, the staff is withdrawn, and the stone is felt for and extracted. In withdrawing the stone, make traction in the axis of the pelvis, and do not rotate the calculus until it is entirely out of the prostatic urethra. Wash or scrape away débris or incrustation, see that no other stone is present, syringe out the bladder with hot corrosive-sublimate solution (1 : 5000), insert a tube, apply antiseptic dressings around the tube, and put on a T-bandage. The end of the tube which is external to the dressings is fastened to the tails of the T-bandage. A rubber cloth is put on the bed, under the body and legs, and the patient's buttocks rest upon a mass of old linen, the scrotum being raised on a pad. The knees are bent over pillows. Change the linen as soon as it becomes wet. Remove the tube in forty-eight hours. The urine begins to come by the urethra from the eighth to the twelfth day. In children the incision is not so long and is dilated with forceps instead of with the finger; no tube is required. In lateral lithotomy the prostatic and membranous urethra are opened, the prostate gland is partly divided with the knife, and the wound is dilated with the finger.

Suprapubic Lithotomy.—This operation is the removal of a stone through an opening over the pubes. It is in many instances the preferable operation. It is used for the removal of multiple calculi, for very hard stones, for stones above one and a half inches in diameter, for calculi in men with enlargement of the prostate, for foreign bodies incrusted with sediment, when the perineum is deep, when the pelvic outlet is narrow, and when the urethra will not permit the use of a lithotrite. The patient is prepared as for lateral lithotomy, except that the pubes are shaved and the lower part of the abdomen and the upper part of the thighs are disinfected. During the operation the penis is covered with an antiseptic cloth. The instruments required are a scalpel, a probe-

pointed bistoury, scissors, a tenaculum, blunt hooks, hæmostatic forceps, retractors, dissecting-forceps, a dry dissector, an electric forehead-light, a rectal bag, a brass syringe, a sound, rubber tubing, rubber catheters, stone-forceps and scoops, a bladder-tube, curved needles and a needle-holder, and a graduated glass jar for injecting the bladder.

In performing the *operation*, place the patient in the Trendelenburg position (Fig. 146). Have an assistant oil the rectal bag and push it above the sphincters. Draw off the urine with a soft catheter, wash out the bladder with warm boracic-acid solution (1 : 32), and inject the bladder with the same solution. In a child under the age of five inject three to four ounces; in an adult inject ten to twelve ounces. Withdraw the catheter, and tie a tube around the penis to prevent the escape of fluid. Some surgeons simply inject air by means of a catheter and a brass syringe or a Davidson syringe. After injecting the bladder, if the viscus is not well lifted up, inject the rectal bag and clamp its tube with forceps. In a child inject from two to four ounces of warm water; in an adult inject ten ounces. Make a three-inch incision in the median line of the hypogastric region, terminating over the symphysis. When the perivesicular connective tissue is reached, cut it. If the peritoneum should appear, push it up. Hold the wound-edges apart by retractors. The large veins are seen, giving the bladder a blue color. Avoid these veins if possible, but even if they should be cut bleeding will stop when the bladder is opened and the rectal bag is removed. Clamp bleeding vessels; catch the bladder transversely with a tenaculum at the upper angle of the wound; open the viscus in the middle line above, and cut toward the pubes; catch the edges of the cut with hæmostatic forceps, and remove the tenaculum. Explore the bladder, remove the stone or stones, scrape away incrustations, ligate bleeding

vessels outside the bladder, and irrigate the viscus with hot bichloride-of-mercury solution (1 : 5000). Introduce a tube into the bladder, and attach to its external end a long tube to siphon off the urine. Suture the muscles and fascia at the upper part of the wound, but, as a rule, do not suture the bladder. Bladder-sutures rarely hold, and become incrusted with urinary salts. Dress with dry antiseptic gauze and a rubber dam, the dressings and binder being split to go around the tube. Catch the urine which siphons over in a bottle containing some antiseptic fluid. Change the dressings as often as they become wet. Take out the tube in four or five days, and allow the wound to heal by granulation.

Crushing of Vesical Calculi.—This is now done in one sitting, the old operation of Civiale, requiring repeated crushings, being obsolete.

Litholapaxy (Bigelow's operation, or rapid lithotrity) is the operation for removing a stone in the bladder in one sitting by thoroughly crushing the stone and completely washing away the fragments. Sir H. Thompson says this method is suited to twenty-nine cases out of thirty. Litholapaxy should be employed if the bladder will hold at least six ounces of fluid and is in a fairly healthy condition; if the urethra is tolerant and penetrable by instruments; if the stone is not too hard, does not weigh over two and three-quarter ounces, and is not over two inches in diameter. It is not suited for multiple calculi, for large and hard calculi, for encysted stones, or for a patient with enlarged prostate, with vesical atony, or with cystitis. An easily dilatable stricture need not prevent the surgeon from doing litholapaxy. The stricture can first be dilated, and later Bigelow's operation can be performed, but firm, gristly strictures demand a cutting operation. If the urethra is intolerant of instrumentation, the patient being prone to febrile attacks when it is attempted, cut instead of crushing. People with kidney

disease will do better after this operation than after cutting (Cage). In diabetes, locomotor ataxia, and conditions of exhaustion patients are best treated by Bigelow's operation, unless cystitis exists.

The preparation of the bladder is the same as for lithotomy. Be sure to measure the stone, and to ascertain also whether a lithotrite can readily be introduced and manipulated. The instruments required are a stone-sound, lithotrites (several sizes), an evacuating-bulb and tubes (straight and curved), soft catheters, a glass irrigator to inject the bladder, and instruments in case the surgeon is forced to cut. The patient is anæsthetized and is placed upon his back, a pillow is inserted under the pelvis, and he is well wrapped up. The urine is drawn and a measured amount of warm boracic acid is allowed to flow into the bladder. This plan is better than having the patient retain his urine, as in the latter case there is no certainty as to the amount of fluid in the viscus. It is well to introduce at least five or six ounces of fluid if possible. If the bladder will not hold four ounces, the operation is unsafe (Thompson). The lithotrite is now introduced, the handle being gradually raised to a vertical position as the penis is drawn up on the shaft, but not being depressed until the instrument has passed by its own weight into the prostatic urethra. Thompson's plan for catching the stone is as follows: After introducing the lithotrite, let its lower end rest for a few seconds on the bottom of the bladder, so that currents will subside; then draw back the male blade, wait a second, close it again, and in almost every instance the stone is caught. If the stone is caught, press firmly to see that the calculus is well held, lock the instrument, and break the foreign body by screwing. When resistance suddenly ceases the stone has either slipped or has been crushed; if crushed the blades should have been felt forcing through the stone and the calculus should have been heard to break. When

resistance ceases catch and crush again as above directed. Rapid movements with the lithotrite are improper, as they establish currents which are apt to push away the stone. If the above manœuvre does not catch the stone, see if the calculus be near the neck of the bladder. Pull the instrument close to the vesical neck, and open it, not by pulling the male blade, but by pushing the female blade. If the operator still fails to catch the stone, or if, after crushing, a large fragment knocks against the evacuator, which fragment cannot pass, conduct a careful search: turn the blades to the right side, open, and close; then to the left side, open, and close; next turn the point around behind the prostate, open, and close. In these side turns of the lithotrite, in order to crush, turn the instrument very slowly, so as to detect the catching of the bladder-wall if it has occurred, and crush the stone in the middle of the bladder with the blades up. After crushing several times, proceed to evacuate. Fill the aspirator with warm boiled water or with warm solution of carbolic acid (10 m. to the pint). Insert an evacuating catheter, its point being in the centre of the bladder, let the fluid and fragments run out, and attach to the catheter the aspirator; turn the valve, and compress and relax the bulb so that an ounce or more of fluid is forced in at each squeeze, the compression coinciding with expirations. The débris falls into a bulb, and the pumping is continued until fragments cease to pass, whereupon the point of the catheter is pushed against the floor of the bladder and another trial is made. If fragments which cannot gain exit are felt knocking against the tube, withdraw the evacuator, crush again, and again use the aspirator. When no more débris comes away and no more fragments are felt, withdraw the tube and carefully sound the bladder. Keyes advises the operator to seek for a final fragment by listening with a stethoscope while pumping at the bulb and searching the bladder with the tube. This opera-

tion will rarely occupy over forty minutes, though Bigelow has protracted it for three hours, the patient recovering. A serious complication is severe bleeding, due to damage done with the instrument or to the presence of a tumor which easily bleeds. The injection of moderately hot water usually checks hemorrhage, but if bleeding is dangerous in amount the operation of litholapaxy should be abandoned, and a suprapubic lithotomy be performed instead.

If clogging of the instrument with fragments occurs, forcible pushing of the blades together repeatedly will probably amend it; but it should never happen, as the occurrence indicts the operator of carelessness or of ignorance in using an improper tool. A lithotrite with a fenestrated blade will not lock. If the blades become forcibly and hopelessly locked, make a perineal section, clear out the blades, and then withdraw the instrument. Forbes's lithotrite is a very powerful tool.

After-treatment.—Put the patient to bed, apply a bag of hot water to the hypogastrium, and give him a hypodermatic injection of morphia as he recovers from ether. Give a hot hip-bath every night, and administer every day liquor potassii citratis in moderate doses. If urethral fever occurs, use quinine and morphia, wash the bladder several times daily with warm boracic-acid solution, and tie in a rubber catheter. If retention occurs, use the catheter. If cystitis appears, treat as in an ordinary case. The urine ceases to be bloody in two or three days, and the patient may get up in a week.

Litholapaxy in Male Children.—It was considered until quite recently that a child, because of the small size of its bladder, the small diameter of the urethra, and the readiness with which the mucous membrane is ruptured by even slight violence, was a bad subject for crushing. Lateral lithotomy is known to be eminently successful when performed upon children. The elder Gross did this opera-

tion upon 72 children with only 2 deaths. Dr. Keegan, however, has persuaded the profession that rapid lithotrity is perfectly applicable to children: he shows that the bladder of a child even less than two years of age is quite large enough to allow the surgeon to manipulate an instrument, that the mucous membrane is in no danger if the operator be careful, and that the urethra is by no means so small as was supposed. The urinary meatus must often be incised, and after doing this, Keegan states, there can be passed in a boy of from three to six years a No. 7 or 8 lithotrite (English), and in a boy of from eight to ten years a No. 10 or even a No. 14. It is, however, just to state that the operation is more delicate than a like procedure on older persons, and that no one is justified in doing it who has not had considerable experience in adult cases. Furthermore, it should be noted that Keegan's mortality by this operation has been 4.3 per cent., while Gross's mortality from lateral lithotomy on children was 2.67 per cent.

Special points of litholapaxy on male children are as follows: Use well-fenestrated lithotrites; have a stylet to punch out the fragments blocking the evacuator; and crush the stone to a fine mass. There can usually be employed a No. 8 lithotrite and a No. 8 evacuating-tube.

Operation for Stone in Women.—If the stone be small, give the patient ether, place her in the lithotomy position, dilate the urethra with a uterine dilator until it admits the index finger, and remove the stone with the finger, the scoop, or the forceps. If the stone is found to be too large to pass, crush it with a lithrotrite and get rid of the débris by the evacuator. Large stones (two ounces) may require a suprapubic lithotomy. Vaginal lithotomy is never required. If done, it is very likely to leave as a legacy a vesico-vaginal fistula. In female children dilate the urethra, crush the stone, and evacuate.

Cystotomy.—This term means the opening of the bladder, and it is usually applied to an opening made for drainage, for diagnosis, for the removal of stones and tumors, and for the treatment of ulcers. This opening may be done by (1) a suprapubic cut (as in suprapubic lithotomy), (2) a lateral perineal cut (as in lateral lithotomy), or (3) a median perineal cut (as in median lithotomy).

Suprapubic Cystotomy.—To explore the bladder, to treat an ulcer, or to remove a tumor, perform suprapubic cystotomy and illuminate the interior of the bladder by the rays of an electric lamp, which appliance is fastened with a mirror to the forehead of the operator. The inflation of the rectum is a decided advantage. If an ulcer is found, it is scraped with a curette or a spoon. Most cases of tumor require suprapubic cystotomy. It is true that a small single growth at the vesical neck is accessible by median cystotomy, but the area for manipulation is very narrow and the growth cannot be seen. Every large growth, all cases of multiple tumors, and all cases of tumor with great depth of perineum or with enlarged prostate require suprapubic cystotomy, an operation which allows one to feel and to see the growth, which gives room for manipulation, and which permits thorough exploration of the entire bladder. The patient is put in the Trendelenburg position (Fig. 146). After opening the bladder as for stone, hold the edges of the incision apart by specula (specula of Keen or Watson) or by retractors and throw in the electric rays. Growths when seen can be twisted off, a pair of forceps holding the base and another pair being used to twist. Broad growths are transfixed, ligatured, and severed. Some growths (as cancer) are removed piece by piece with Thompson's forceps, the base being scraped. Soft growths are scraped away with a curette, a spoon, or a finger-nail. If bleeding is severe, check it by pressure, by iced water, or even by the actual cautery.

Median Cystotomy.—The same incision is made in the perineal raphé in median cystotomy as for median lithotomy. A grooved staff is introduced and is hooked up under the pubes; an incision is made into the membranous urethra and is extended backward for three-quarters of an inch, and a finger is carried into the bladder. If searching for a growth, find it with the finger, catch it in Thompson forceps, and twist it off. Soft growths can be scraped away. Stop bleeding by digital pressure or by injections of iced water. If median cystotomy does not allow access to the tumor, perform suprapubic cystotomy.

Growths in the Female Bladder.—Dilate the urethra as in a case of stone, and scrape, twist, pull, or ligature the growth away. If the growth is large or if there are multiple growths, perform suprapubic cystotomy.

XXXV. DISEASES AND INJURIES OF THE URETHRA, PENIS, TESTICLES, PROSTATE, SPERMATIC CORD, AND TUNICA VAGINALIS.

Injuries may arise from traumatism to the perineum or the penis, from cuts and twists of the penis, from the popular "breaking" of a chordee, from tying strings around the organ, from forcing rings over it, from the passage of instruments, or from the impaction of calculi. The writer saw one man with a glass rod broken off in the canal, he having been in the habit of introducing it at the dictate of morbid sexual excitement. A patient in the Insane Department of the Philadelphia Hospital had a ring around his penis, which organ was lacerated into the urethra. These injuries are treated on general principles.

Perineal Bruises.—If the perineum be bruised without rupture of the urethra, the perineum and scrotum swell and become discolored; water is passed with difficulty because

of the extravasation in the periurethral tissues occluding more or less the canal; the water is not bloody; and there are pain and profound shock. Some authors designate as rupture those cases in which laceration of the spongy tissue occurs, without involvement of the mucous membrane or of the fibrous coat, but they are properly contusions.

Treatment of Perineal Bruises.—Place the patient in bed and establish reaction, and when reaction is complete employ opiates for the relief of pain. Place lint, wet and kept wet with lead-water and laudanum, upon the perineum, alternating every two hours with a fifteen-minute application of the ice-bag. If, notwithstanding these measures, swelling continues, introduce a silver catheter (No. 12 E.), tie it in, and make firm pressure upon the perineum by a firmly-applied T-bandage or by a crutch braced against the thighs or the foot-board of the bed. Even when swelling is slight retention may occur from projection into the canal of the urethra of a submucous blood-clot. *Punctured wounds of the urethra* require ordinary dressings. *Incised wounds of the urethra*, when longitudinal, are closed by suture. Healing is rapid, and ill consequences are not to be feared. Stricture does not follow. When the wound is transverse, introduce a catheter, suture the wound over the instrument, and remove the catheter at the end of the third day. If a catheter cannot be introduced, employ sutures, but at the first evidence of extravasation open the wound, and if drainage is not free perform an external perineal urethrotomy.

Rupture of the Urethra.—By this term is meant a lacerated or a contused wound of the urethra, destroying partially or entirely the integrity of the canal. A lacerated wound can be induced by fracture of the cavernous bodies during erection, the symptoms being severe hemorrhage, intense pain, retention of urine, and inability to pass an instrument; infiltration of urine occurs, and gangrene is a

common result. The writer has seen one case of rupture of the penile urethra due to a man's slipping while shaving, the penis being caught in a partially open drawer, the drawer being shut by his body coming against it. Rupture, however, is almost invariably located in the perineum, and it arises when the urethra is suddenly and forcibly pressed against the ramus of the pubes by a blow, by a kick, or by falling astride a beam or a fence-rail. The lesion of urethral rupture consists in some cases of laceration of the spongy tissue and the mucous membrane, a cavity being formed which communicates with the canal, and which fills with urine during micturition. In other cases not only the spongy tissue and the urethral mucous membrane are rent asunder, but the fibrous coat is also torn, the canal opening directly into the perineal tissues, among which a huge cavity forms, that fills with blood and later with clot, urine, and pus. The urethra may be torn entirely across, but in most cases a small portion at least of its circumference is uninjured. Rupture never occurs primarily and alone in the prostatic urethra; it is extremely rare in the membranous urethra unless due to pelvic fracture; and it is very unusual in the penile urethra. The seat of rupture in the great majority of cases is in the region of the bulb. Very rarely is the skin broken.

Symptoms.—The symptoms of rupture of the urethra are—considerable pain, aggravated by motion, pressure, and attempts to pass the water; great shock; in some cases micturition is still possible, blood preceding and discoloring the stream, for some blood usually runs into the bladder; retention soon comes on; in a vast majority of the cases retention is absolute from the very first, and it is due to the interruption in the integrity of the canal and to the occlusion of the channel by blood-clots. Bleeding, which is usually free, lasts for several hours, some little blood generally appearing exter-

nally and much being retained in the perineum, inducing progressive swelling. The presence of blood is regarded as evidence of urethral rupture. The perineal swelling is due to blood which may extend under the fascia to the penis and scrotum; the swelling soon becomes reddish, purple, or even black, and pressure upon it is apt to cause blood to run from the meatus. This swelling enlarges when attempts are made to urinate. After a time, if the surgeon does not act, the urine fills the perineal cavity and widely infiltrates, and there ensue gangrene, sloughing, and sepsis, life being endangered or fistulæ being left as legacies. In rupture of the urethra the course of the extravasated urine will often enable one to locate the seat. In rupture of the membranous urethra, if uncomplicated, the urine remains between the two layers of the triangular ligament until a channel is opened for it by sloughing or by the knife. When extravasation occurs behind the posterior layer of the ligament the urine finds its way to the perineum in the neighborhood of the anus. When the rupture is in front of the anterior layer the urine, directed by the deep layer of the superficial fascia, finds its way into the scrotum and up on the belly, but does not pass into the thighs. A contusion is distinguished from a rupture by the facts that in the former the perineal swelling does not enlarge on attempting micturition, while in the latter it does; and contusion does not cause urethral hemorrhage, while rupture does. A contusion sometimes, but not often, prevents the passage of a catheter; a rupture almost always, but not invariably, does so. The mortality from severe rupture with extravasation is grave. Massing together all cases, the mortality is 14 per cent. (Kaufman).

Treatment.—In recent cases of ruptured urethra the treatment is as follows: immediate perineal section with turning out of the clot; trimming off of lacerated edges; finding the proximal end of the urethra, passing a catheter from the

meatus into the bladder, and leaving it *in situ* until healing has begun around it. In cases with extravasation, lay open freely all pockets of urine and proceed as above. If the proximal end of the urethra cannot be found, either open the bladder by Cock's method of perineal section without a guide, cutting toward the apex of the prostate gland and carrying the incision forward into the rent, or perform a suprapubic cystotomy with retrograde catheterization; that is, push an instrument from the bladder into the wound, and use it to guide a catheter passed from the meatus into the bladder. It is always well to attempt to suture together the divided ends of the canal. The wound is packed with iodoform gauze, and the bowels are tied up with opium for a few days. Many surgeons strongly disapprove of the custom of retaining the catheter, and merely stuff the wound with gauze, the patient urinating through the wound for the first few days, after which time a catheter is used. When the rupture is in the bulb perineal section is performed to permit drainage, the rent is sutured, and a catheter is retained as a support. Whatever method is employed, healing will require from six to eight weeks, and the patient must ever after frequently introduce large-sized bougies.

Foreign Bodies in the Urethra.—These bodies may be calculi, bodies introduced by injury, as shot, bone, etc., bodies entering from a morbid opening into the rectum, or bodies introduced from the meatus, as broken bits of catheters, straws, pins, etc. The *symptoms* vary with the size and the nature of the body. Sometimes there are almost no symptoms; at other times there are found great pain, retention of urine, and hemorrhage. Examination is made by feeling externally with a finger in the rectum and by searching very gently with a sound, taking care not to push the body back. If the bladder is well filled with water when the body becomes impacted, inject a little oil into the meatus, close

the lips with the fingers, and direct the patient to forcibly attempt urination, the surgeon opening the meatus when the urethra is widely distended, the foreign body being often forced out. If this manœuvre fails, and the foreign body is impacted in the pendulous urethra, prevent its backward passage by at once tying a rubber tube around the penis. Try to squeeze the body out, and, if unsuccessful, endeavor to catch it with a wire loop, with a scoop, or with the long urethral forceps. If these methods fail, cut down upon the body and remove it, dividing any existing stricture. If a hair-pin is in the canal, the feet of the pin are almost always pointing to the meatus; to prevent them catching on attempted withdrawal, the penis must be squeezed to approximate the feet, and when they are adjacent a part of a silver catheter is slipped over to retain them in this position, when the pin can be extracted. If this fails, drag the penis against the belly, by rectal touch force the sharp ends out through the integument, cut one end off, and then withdraw the other. An ordinary large-headed pin is forced out in the same way, and when the head is turned externally it is extracted from the meatus. If a lithotrite loaded with fragments be caught in the urethra, the surgeon must perform a perineal section, clean and close the blades, and withdraw the instrument.

Urethritis, or Inflammation of the Urethra.—Urethral inflammations can be divided into two classes: (1) *Simple*, in which infection is due alone to pyogenic cocci, and (2) *specific*, in which the gonococcus is present.

Simple urethritis may be due to several causes, such as traumatism; great acidity of the urine; chancre in the urethra; contact with menstrual fluid, leucorrhœal discharge, the discharge from malignant disease of the uterus, ordinary pus, or acid vaginal discharge; the passage of instruments; irritant diuretics; strong injections; worms in the rectum; and the passage or impaction of foreign bodies. A tem-

porary and mild urethritis sometimes accompanies early syphilitic eruptions. Simple urethritis is usually less severe and prolonged than specific urethritis, though clinically the surgeon cannot invariably distinguish between the two forms. Professor Coplin is persuaded that the gonococcus is never found in the discharge of simple urethritis. In the non-specific inflammation pus is not always present, many cases stopping short of it after a varying period of catarrh, but any catarrh can become purulent.

Traumatic Urethritis.—The pain in traumatic urethritis is coincident with the introduction of the foreign body. The discharge, which may be bloody, mucous, muco-purulent, or purulent, comes on within twenty-four hours.

Treatment.—If the inflammation is slight, prescribe diluent drinks, paregoric, and a saline. If severe, put the patient to bed, apply warm fomentations to the perineum, give diluent drinks, employ suppositories of opium and belladonna, and watch for fever and other complications.

Gouty Urethritis.—This condition first manifests itself in the posterior urethra, not in the anterior, as does clap. Its symptoms are—great vesical irritability; pain on urination; discharge, usually scanty, associated with uric acid in the urine or other symptoms of gout. The *treatment* comprises dieting and the usual remedies for gout. Purgatives are given freely, and full doses of colchicum, piperazine, or the alkalies; hot baths, low diet, diluent drinks, and diaphoretics are indicated. A chronic discharge from the prostatic region is apt to linger; for this there is nothing better than the usual gouty remedies and saline waters with copaiba, cubebs, or sandalwood oil.

Eczematous Urethritis.—Berkeley Hill states that this disease is very obstinate, is probably associated with gout, and is met with in adults of full habit or who are beer-drinkers and who have eczema of the surface of the body.

He states also that the glans penis near the meatus is red and tender, and that the interior of the urethra is in the same condition. Pain is constant, and it is aggravated on micturition. The discharge is scanty. The *treatment* comprises injections of cold water or irrigation with ice-water, and internally the administration of arsenic with the alkalies.

Tubercular urethritis is due to a tubercular ulcer which is most apt to be seated near the vesical neck. There is a little pain on micturition, but there is intense pain at one spot on passing a bougie. The discharge is slight and at times bloody. The bladder is very irritable, and severe cystitis arises and persists. The *treatment* includes fresh air, sunlight, warmth, good food, and cod-liver oil. The bladder is washed out once a day with boracic-acid solution, but after a time the surgeon will be forced to drain by perineal or suprapubic cystotomy.

Gonorrhœa (Clap; Specific Urethritis; Tripper; Venereal Catarrh).—Gonorrhœa is an acute inflammation of the genital mucous membrane, of venereal origin, due to the deposition and multiplication of gonococci in the cells of the membrane and a mixed infection with the cocci of suppuration. In the male, clap begins within the meatus and fossa navicularis and extends backward throughout the length of the urethra. The mucous membrane swells and becomes hyperæmic, and there is a discharge, first of mucus and serum, and then of pus. In severe cases the discharge is bloody (black gonorrhœa). For a week or more the inflammation increases, then becomes stationary for a time, and then declines, the discharge growing less profuse and thinner, a watery discharge lasting for some little time. During the acute stage the entire penis swells and the corpus spongiosum becomes infiltrated with inflammatory exudate. *Chordee* is a painful erection in which the penis bends because of the rigid infiltration of the corpus spongiosum.

Symptoms of Acute Inflammatory Gonorrhœa.—The period of incubation is from a few hours to two weeks. The patient notices on arising a drop of thin fluid which glues together the lips of the meatus, and he feels some pain on urination. The meatus is red and swollen. Within forty-eight hours the *first stage*, or the stage of increase, becomes established. The meatus is now red, swollen, and everted (fish-mouth meatus); micturition causes severe pain (ardor urinæ); chordee occurs, especially when the patient is warm in bed; there is frequent micturition with tenesmus, and a profuse discharge which is yellow, greenish, or even bloody. The complications of this stage are *balanitis* (inflammation of the mucous membrane of the glans penis), *balano-posthitis* (inflammation of the surface of the glans and the mucous membrane of the prepuce), *phimosis* (thickening and contraction of the foreskin so that the glans cannot be uncovered), and *paraphimosis* (catching and fixation of the retracted prepuce behind the corona glandis). In the *second* or *stationary stage*, which lasts from the end of the first week to the end of the second (White), the acute symptoms of the first stage continue. The complications of this stage are periurethral abscess, lymphangitis, solitary and painful bubo of the groin which may suppurate, inflammation of Cowper's glands, inflammation of the prostate or of the bladder, and gonorrhœal ophthalmia. In the *third* or *subsiding stage* the symptoms gradually abate, the discharge becoming scantier and thinner and finally drying up. This stage is of uncertain duration, and in it there may occur *epididymitis*, or inflammation of the epididymis.

Subacute or **catarrhal gonorrhœa** develops in men who have previously had gonorrhœa, as a result of prolonged or repeated coition or of contact with menstrual fluid or leucorrhœal discharge. There is profuse muco-purulent discharge, very little pain on micturition, rarely chordee or marked

irritability of the bladder. In this condition, according to White, gonorrhœal rheumatism (p. 412) is most apt to occur.

Irritative or Abortive Gonorrhœa.—In this disease the symptoms, which are identical with those of beginning clap, do not increase, but are apt to disappear within ten days.

Chronic Urethral Discharges.—Chronic urethral catarrh, which may follow gonorrhœa, is characterized by the occasional presence of a drop of clear tenacious liquid. This discharge becomes more profuse as a result of sexual excitement or the abuse of alcohol.

Chronic Gonorrhœa.—The persistence of a small amount of milky discharge, because of localization of inflammation in one spot or the production of a granular patch or a superficial ulcer, characterizes chronic gonorrhœa. There is some scalding on urination; erections produce aching pain; there are pain in the back and redness and swelling of the meatus. All the symptoms are intensified by sexual excitement, by coitus, by violent exercise, or by alcoholic excess.

Gleet.—In gleet the lips of the meatus are stuck together in the morning, and squeezing them discloses a drop of opalescent muco-purulent fluid. During the day the discharge is rarely found. There are frequency of micturition, pains in the back, and dribbling of urine, and a bougie will find a stricture of large calibre. A discharge may be maintained by *chronic prostatitis.* In this condition there are frequency of micturition; a sense of weight or dull pain in the perineum; diminished projectile force of the stream of urine; the first portion of urine, if collected in a glass, is more turbid than the second portion (Ultzmann); the sediment consists of "prostatic epithelium, muco-pus, and mucous shreds" (White); there is often a tendency to sexual excitement and premature emission.

Treatment of Acute Gonorrhœa.—Abortive treatment should be tried if the case is seen early. The writer's plan is to

cleanse the urethra several times a day by injecting peroxide of hydrogen (15-volume solution diluted with an equal amount of water). After each injection of peroxide introduce oil of cinnamon into the urethra by means of a metal-nozzled atomizer or even an ordinary syringe (the oil is mixed with benzoinol, three solutions being used, the strength being respectively 1 drop, 2 drops, and 3 drops to the ounce). The mild solution of oil of cinnamon is used the first day, the 2-drop solution the second day, the 3-drop solution the third day if the urethra will tolerate it.[1] Other abortive methods are the use of hot retro-injections of corrosive-sublimate solution (1 : 20,000), two pints being run through the urethra once a day, strong injections of nitrate of silver or of tannin, scraping the meatus and the urethra adjacent with cotton, and injecting 15 drops of a 3 per cent. solution of nitrate of silver. If in seventy-two hours the symptoms are not greatly improved, abortive treatment should be abandoned (Horwitz). In treating *a developed case*, order plain, non-stimulating diet and the avoidance of alcohol, sexual excitement, wet, and violent or prolonged exercise. The patient should sleep under light covers and drink much water daily (Seltzer, Apollinaris, or ordinary water containing bicarbonate of soda). If the foreskin is long, the discharge should be caught by placing bits of absorbent cotton over the meatus and within the prepuce. If the foreskin is short, cut a small opening in a square piece of old linen, slip this linen over the glans, catch it back of the corona, and bring the ends forward with the prepuce. If the glans is completely naked, pin an old stocking-foot upon the undershirt and in it hang the penis.

Irritative gonorrhœa will subside in a few days. The above treatment should be applied, and the urethra should be washed out several times daily with peroxide of hydrogen.

[1] *Medical News*, Oct. 21, 1893.

In *catarrhal gonorrhœa* at once order injections (1 grain to the ounce of sulphate of zinc; or zinci sulphas gr. viij, plumbi acetas gr. xv, water ℥viij; or gr. v of sulphocarbolate of zinc to ℥j of water; or White's prescription of ʒj each of acetate of zinc and tannic acid, ʒiij of boric acid, ℥vj of liq. hydrogen. peroxid.). Use for injecting a blunt-pointed hard-rubber syringe of a capacity of three drachms. Let the patient sit on a chair, his buttocks hanging over the edge; throw in a syringeful and let it at once run out; throw in another syringeful and hold it in from three to five minutes. In *acute gonorrhœa* order two capsules three times a day, each capsule containing 5 grains of salol, 5 grains of oleoresin of cubebs, 10 grains of balsam of copaiba, and 1 grain of pepsin. After the patient micturates he should employ a mild astringent injection. If an astringent injection causes much pain, use a sedative injection—ʒij of boracic acid, gr. viij of aqueous extract of opium, and ℥viij of liquor plumbi subacetatis dilutus. As the inflammation subsides increase the strength of the injection. A good plan is to order an eight-ounce bottle and eight half-grain powders of sulphate of zinc. Direct the patient to fill the bottle with water, in which one powder is dissolved; when this is used dissolve two powders in a bottleful of water, and so progressively increase the strength. When the discharge ceases stop the injections gradually. Whenever a syringeful is taken from the bottle a syringeful of water is put into the bottle, and thus pure water is soon obtained, at which point injection is discontinued.

Ardor urinæ is relieved by urinating while the penis lies in hot water and by administering an alkaline diuretic. *Chordee* requires a bowel-movement in the evening and sleeping in a cool room, under light covers, and on a hard mattress; bromide is given several times daily, and a considerable dose is given at night; it may be necessary to use

suppositories of opium and camphor or to give hyoscine. *Balanitis* requires frequent washing with warm water, drying with cotton, and dusting with borated talc or with boric acid and subnitrate of bismuth (1 : 6). *Balano-posthitis* requires lead-water and laudanum and injections of black wash under the prepuce until œdema of the foreskin subsides, and then cleanliness externally and a powder. *Phimosis* requires soaking the penis in hot water, injections beneath the foreskin of hot water, followed by black wash and lead-water and laudanum externally. If this fails, circumcise. For *paraphimosis*, grasp the head of the penis with the left hand, squeeze the blood out, and try to push the head back while with the right hand effort is made as if to lift the individual by his penis. If this fails, cut the collar on the dorsum with scissors. *Bubo* requires iodine, blue ointment, a spica bandage, and rest. If a bubo suppurates, it must be opened. *Acute prostatitis* and *cystitis* require confinement to bed, a milk diet, the use of alkaline diuretics, hot sand-bags to the perineum and hypogastrium, suppositories of opium and belladonna, leeching the perineum, and the discontinuance of the balsams and injections. *Abscess of the prostate* requires instant opening. In *retention of urine* the patient should try to pass the urine while in a hot bath; if this fails, use a soft catheter. After relieving the bladder put the patient to bed and use hot sand-bags as for prostatitis. *Chronic prostatitis* requires cold hip-baths, cold-water enemata, deep urethral injections, plain diet, avoidance of alcohol and over-exertion, counter-irritation of the perineum, and the relief of stricture or phimosis. In *epididymitis*, put the patient to bed, stop injections, shave the hair from the groin and leech over the cord, elevate the testicles, keep the parts covered with lint wet with lead-water and laudanum, and from time to time apply an ice-bag. Give a cathartic, a fever-mixture, and suitable doses of bromide of potash and morphia. When tenderness

subsides strap the testicle. In *gonorrhœal ophthalmia*, place a watch-crystal over the unaffected eye, put the patient in a darkened room, wash out the affected eye often with hot boracic-acid solution, keep the pupil dilated with atropine, leech the temple, give purgatives, and employ hot mustard foot-baths. Always send for an ophthalmologist.

Treatment of Chronic Gonorrhœa.—In chronic gonorrhœa, try to locate any existing granular or ulcerated patch with a bulbous bougie. When the point is discovered apply to it, by a deep urethral syringe, a few drops of a 2 per cent. solution of nitrate of silver. The strength of the silver solution can gradually be increased, or other solutions can be substituted (sulphate of copper or sulphocarbolate of zinc). Pass a large bougie every other day. Copious retro-irrigation with hot solutions of corrosive sublimate (1 : 20,000) does good. Horwitz injects into the bladder once a day a pint of water containing $3\frac{1}{4}$ grains of permanganate of potash, and the patient voids it by an act of micturition. The treatment of *gleet* is the same as that of *stricture.*

Gonorrhœa in the female may affect the vulva, the vagina, the urethra, or the uterus. The *treatment* for *vulvitis* is to place the patient upon a low diet and put her at rest with the pelvis elevated; every two or three hours spray the parts with peroxide of hydrogen, dry them with absorbent cotton, and dust them with equal parts of starch and oxide of zinc. In severe cases purge, use hot baths, apply lead-water and laudanum locally or paint the vulva with silver solution (gr. xl to ℥j), and leech the groins. If the vulvo-vaginal gland suppurates, open it. For *vaginitis*, follow the same general directions. Syringe out the vagina every two hours, first with Oj of hot solution of bicarbonate of soda, next with Oj of hot water, and finally with Oj of astringent solution (a teaspoonful of lead acetate, a teaspoonful of zinc sulphate, a teaspoonful of alum, or four teaspoonfuls of tannin

to the pint of hot water) (White). Peroxide of hydrogen followed by oil of cinnamon does good. As the attack subsides use vaginal suppositories each containing gr. v of tannic acid. For *urethritis*, use astringent injections locally and copaiba and cubebs by the mouth. In chronic cases, use strong solutions of silver nitrate. For *uterine gonorrhœa*, observe the same general management. Swab out the uterus with tincture of iodine; use tampons of iodoform gauze and injections of peroxide of hydrogen and oil of cinnamon.

Stricture of the urethra, or narrowing of the urethral calibre, is divided into *inflammatory*, *spasmodic*, and *organic*. *Inflammatory* or congestive stricture is not a stricture, but is an inflammatory swelling of the mucous membrane. *Spasmodic* stricture does not exist alone, but complicates organic stricture, a hyperæsthetic urethra, or an inflamed bladder. *Organic* stricture is a fibrous narrowing of the urethra, due, as a rule, to chronic gonorrhœal inflammation or to traumatism. Traumatic strictures occur in the bulbous or membranous urethra; gonorrhœal strictures occur in the penile, bulbous, or membranous urethra. Stricture never forms in the prostatic urethra. The more fibrous a stricture is, the more it narrows the urethra and the less dilatable it is. A stricture may be annular (forming a ring around the urethra), tubular (surrounding the urethra for a considerable distance), or bridle (when a band crosses the urethra from wall to wall). The nearer a stricture is to the meatus, the more fibrous it is.

Results of Stricture.—The urethra back of the stricture dilates, a pouch forms, drops of urine collect and decompose, and a chronic inflammation results in the mucous membrane or the parts adjacent, which inflammation may go on to ulceration or to periurethral abscess. A urinary fistula results from the opening of a periurethral abscess. In stricture the stream of water is small, twisted, often forked, and it dribbles long after the conclusion of micturition. A chronic dis-

charge is apt to exist, varying in amount. Retention of urine may occur, not from obliteration of the tube by the growth of the stricture, but by swelling in the neighborhood of the stricture, due to some complication (cold, wet, venereal excitement, the use of alcohol, over-exertion, etc.). Spasm of the muscles results, and contact of the urine increases the spasm and closes the urethra. Spasm may exist in the urethra itself and in the muscles of the neck of the bladder, but is only a temporary condition. In old strictures the bladder is hypertrophied and often fasciculated, and is very liable to cystitis. The diagnosis of stricture and of its location is made by the use of exploratory bougies.

Treatment of Stricture.—Strictures of large calibre in the deep urethra require gradual dilatation with conical steel bougies. A bougie is introduced every third or fourth day, the size being gradually increased. Never anoint a bougie with cosmoline, as it may become a nucleus for a stone in the bladder; use oil or glycerin. If the meatus is too small to admit a full-sized bougie, cut it with a knife. Strictures of large calibre in the pendulous urethra, if elastic, are treated by gradual dilatation; if fibrous and contractile, by internal urethrotomy. In performing internal urethrotomy, prepare the patient carefully; for several days before the operation give salol and boracic acid by the mouth, and wash out the bladder repeatedly with boracic-acid solution. Be thoroughly aseptic. Before cutting irrigate the urethra with corrosive sublimate (1 : 5000), and after cutting irrigate again and tie in a rubber catheter. These precautions will prevent urethral fever. In cutting, insert Gross's urethrotome back of the stricture, spring out the blade, cut the stricture on the roof of the urethra, close the blade, withdraw the instrument, and introduce a full-sized bougie.

Strictures of the meatus require incision with a knife and the use of a meatus bougie until healing is complete.

Strictures of small calibre in front of the membranous urethra require gradual dilatation and, if this fails, internal urethrotomy or divulsion. For divulsion the patient is prepared as for internal urethrotomy. The divulsor of Gross or of Sir Henry Thompson is introduced, the blades are separated, the instrument is withdrawn, a large bougie is passed, and a catheter is tied in the bladder. Strictures of small calibre in the deep urethra require gradual dilatation; if this fails, employ external urethrotomy. In strictures of the deep urethra, if only a filiform bougie can be introduced, the bougie can be left in place and in a day or two another can be slipped in beside it, until in a few days the channel is permeable by a metal bougie. A tunnelled catheter can be slipped over the bougie, both be withdrawn, and a metal bougie be passed. A tunnelled and grooved staff can be carried in over the bougie and external urethrotomy be performed. Thompson's dilator can be carried over the bougie and the stricture be divulsed. Maisonneuve's urethrotome can be carried over the bougie and internal urethrotomy be performed (White mentions four of these plans, but disapproves of divulsion). In impassable stricture of the deep urethra, perform external perineal urethrotomy without a guide (the operation of Cock or of Wheelhouse).

Epispadias is a congenital cleft in the corpora cavernosa, the roof of the urethra being absent.

Hypospadias is a congenital cleft on the floor of the urethra, this channel being a gutter instead of a canal.

Chancroid (Soft Chancre; the Local Venereal Sore).—A chancroid appears soon after intercourse, usually within five days, always within ten days. It is first manifested by a pustule which ruptures and discloses an ulcer. This ulcer has sharply-defined and undermined margins; it looks "punched out;" the base is gray and sloughy; the discharge is profuse, purulent, foul, and auto-inoculable, and

causes fresh chancroids by flowing over the parts. The area around a chancroid is red and inflamed, and considerable pain is apt to be complained of. The original chancroid spreads and new sores appear. The edge of a chancroid is not indurated unless caustics have been used or there is mixed infection with syphilis. Inflammatory induration fades gradually into the tissues, but the induration of a hard chancre is sharply defined. When a chancroid after a time displays marked and sharply-outlined induration, it means a mixed infection of chancroid and syphilis. Chancroids are not followed by constitutional symptoms, but are apt to be accompanied by painful inflammatory buboes which are prone to suppurate. When inflammation in chancroids is high a rapidly destructive ulceration known as *phagedena* may arise.

Treatment.—Ordinary cases of chancroids are treated by spraying with peroxide of hydrogen, drying with cotton, touching each sore first with pure carbolic acid and then with pure nitric acid, and dusting with iodoform or with calomel. Every few hours after this application the patient soaks the penis in hot salt water (a teaspoonful to half a pint), sprays the sores with peroxide of hydrogen, dries with cotton, and dusts with iodoform or with calomel. As soon as granulation begins, dress with 1 part of ointment of nitrate of mercury to 7 parts of cosmoline. Mild cases do well without cauterizing, peroxide of hydrogen being frequently used and a drying powder being employed. In chancroids with phimosis, slit up the foreskin, burn the edges of the wound with pure carbolic acid, and treat the sore by cauterization. A set circumcision often fails because of infection of the stitch-holes. Phagedena requires the internal use of iron, quinine, and milk punch, and the local use of powerful caustics (bromine or nitric acid) or even of the actual cautery. In some cases continuous antiseptic irrigation is valuable. When a bubo first begins, order rest,

apply iodine and ichthyol, and make pressure by a spica bandage of the groin. If pus forms, incise, curette, cauterize with pure carbolic acid, cut away hopelessly infiltrated skin, and pack the wound with iodoform gauze.

Phimosis is a condition of the prepuce that renders retraction over the glans impossible. It is usually congenital, but it may arise from inflammation. Congenital phimosis causes retention of sebaceous matter, which decomposes and lights up inflammation. The prepuce is apt to grow fast to the glans. Congenital phimosis may induce irritability of the bladder, incontinence of urine, prolapse of the rectum, and various nervous symptoms. The treatment is *circumcision*. Grasp the foreskin and the mucous membrane with two forceps, draw them forward, catch the skin (at the point it is desired to cut) horizontally between the handles of a pair of scissors, and cut off the redundant prepuce. Retrench the excess of mucous membrane by cutting around with scissors one-quarter of an inch from the glans, stitch the skin to the mucous membrane, and dress antiseptically (Fig. 171).

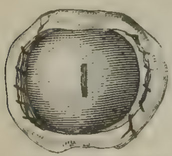


FIG. 171.—Circumcision Completed (Esmarch and Kowalzig).

Fracture of the penis, which is a laceration of the cavernous bodies with extravasation of blood, occurs occasionally during coition. The treatment requires cold and bandaging to arrest bleeding, and occasionally incisions to let out clot.

Gangrene of the penis arises from phagedena, from tying constricting bands around the organ, from fracture with excessive hemorrhage, and from paraphimosis. If extensive, it requires amputation.

Cancer of the penis is commonest in persons with phimosis. In a limited epithelioma of the foreskin circumcision is employed; if cancer affects the glans, amputation is required.

Amputation of the Penis.—Ricord advises cutting off the organ with a single stroke of the knife, making four slits in the mucous membrane of the urethra, and stitching each of these flaps to the skin. Treves splits the skin of the scrotum along the raphé, separates the halves of the scrotum down to the corpus spongiosum, passes a metal catheter down to the triangular ligament, inserts a knife between the corpus spongiosum and the corpora cavernosa, withdraws the catheter, cuts the urethra across, detaches the urethra from the penis back to the triangular ligament, cuts around the root of the penis, divides the suspensory ligament, detaches each crus from the pubes, slits up the corpus spongiosum half an inch, stitches its edges to the rear end of the scrotal incision, introduces a drainage-tube, ligates the vessels, and sutures the wound.

Hypertrophy of the prostate gland is a senile change occurring only after the age of fifty, and being most apt to occur after the age of sixty. All the lobes may be enlarged equally, all may be enlarged but unequally, or only one lobe may be enlarged. Prostatic hypertrophy causes narrowing and lengthening of the urethra, and gives this tube a tortuous course. The opening of the urethra into the bladder is pushed to a higher level, and there forms behind it a pouch in which urine collects. This urine, which is known as *residual urine*, may collect in large quantity; it cannot be voluntarily expelled, and it is apt to decompose, producing cystitis. The bladder enlarges, thickens, and becomes fasciculated, micturition becoming very difficult and sometimes impossible. An enlarged middle lobe will effectually block the urine until the bladder becomes greatly distended. The ureters distend, so do the renal pelves and calyces, and surgical kidney may develop.

Symptoms.—In 80 per cent. of all cases there is only slight inconvenience. The stream of urine is slow to start and falls

feebly from the end of the penis. The last drops fall entirely without control, and there are occasional episodes of nocturnal frequency of micturition. In 20 per cent. of all cases the bladder cannot entirely be emptied and residual urine collects in the bladder. Frequency of micturition comes on, particularly at night; the patient has to get up often; the bladder never feels empty; and cystitis is apt to arise. The urine, at first acid and clear, becomes neutral and cloudy, and finally ammoniacal and turbid, and contains bacteria, muco-pus, precipitates of phosphate, and blood. Above the pubes there is aching pain soon spreading to the perineum, which pain is increased when the bladder is distended and during micturition. The rectum becomes irritable, and piles form or prolapse of the mucous membrane occurs. Retention of urine may take place. The bladder becomes thin and distended or hypertrophied, rigid, and fasciculated. In rare cases true incontinence is caused by the median lobe growing toward the neck of the bladder and preventing closure. The health breaks down because of pain, restless nights, indigestion, and disorder of the bowels. The kidneys may become involved (inflammation of the pelves or calyces, or surgical kidney) and suppression may occur. Calculi may form in the bladder. Death is due to exhaustion, suppression of urine, or septic cystitis. If a foul catheter is used, septic cystitis is certain to occur; but micro-organisms sometimes enter by passing along the urethral mucous membrane.

Treatment.—Prevent cystitis by emptying the bladder each evening with a Coudé catheter which is strengthened by a filiform bougie as a stylet (Brinton). Teach the patient to use the instrument himself. The catheter should be kept in corrosive-sublimate solution (1 : 5000), and before using it should be washed with ethereal soap and water and then with corrosive sublimate (1 : 1000); after using it should be again cleansed and replaced in the solution. If there is a

great amount of residual urine, withdraw only a portion of it at a time. Tell the patient to avoid violent exercise, cold, damp, sexual excitement, and the use of alcoholic liquor, prevent constipation and indigestion, and direct him to drink plenty of Poland water. If much residual urine exists or if cystitis begins, wash out the bladder twice a week with boracic-acid solution and give salol or boracic acid by the mouth. If the suffering becomes severe, if the patient cannot urinate without the use of an instrument, and if catheterization is painful, perform prostatectomy by suprapubic or perineal incision, according to the case, or drain by perineal section.

Retained Testicle.—The testicle may be arrested in its passage to the scrotum: it may remain in the lumbar region; it may reach only the internal abdominal ring; it may lodge in the inguinal canal; it may emerge from the external ring, but fail to enter the scrotum; or it may pass into unnatural positions, as into the perineum or the crural canal. It may or may not be functionally active. A retained testicle is subject to repeated attacks of orchitis, and it is apt to become sarcomatous. Sometimes a testicle descends after being retained for months.

Treatment.—If one testicle is undescended one year after birth, and the other testicle is sound, the former should be removed. In some rare cases it is possible to draw the gland into the scrotum and fasten it.

Orchitis is inflammation of the testicle. *Acute* orchitis may be due to cold, wet, traumatism or epididymitis, gout, mumps, rheumatism, or fever. The testicle is round, swollen, tender, and very painful, the scrotum is red and swollen, the tunica vaginalis fills with fluid, and there is fever. *Chronic* orchitis results from the acute form or from a chronic urethral inflammation, and is almost always combined with epididymitis. Syphilis or tubercle may be responsible for

chronic orchitis. The *treatment* of the *acute* form requires rest in bed and applications as for epididymitis (see below). The *chronic* form requires the removal of the causative lesion, a suspensory bandage, inunctions of ichthyol or mercurial ointment, and iodide of potassium by the mouth. Strapping may do good. Castration may be required.

Castration (Excision of the Testicle).—In this operation an incision is made over the cord, commencing just outside the external ring and running down over the base of the tumor. Divide the cord near to the tumor, remove the testicle, ligate the spermatic artery alone, and then ligate the entire thickness of the cord. It is often advisable to remove a considerable amount of scrotal skin.

Epididymitis, or inflammation of the epididymis, is due to inflammation of the urethra. It is apt to occur in the stage of decline of a gonorrhœa, and is announced by a complete cessation of the discharge. *Acute* epididymitis is characterized by swelling about the testicle, pain in the groin, and tenderness over the posterior part of the testicle. The pain becomes acute, swelling rapidly increases, and the constitution sympathizes. The swelling is due partly to engorgement of the epididymis and partly to fluid in the tunica vaginalis (acute hydrocele). *Chronic* epididymitis is usually linked with orchitis, and it follows an acute attack or a chronic urethral inflammation. *Treatment* by puncture with an aseptic tenotome, if fluctuation is marked, relieves tension and pain. Leeching, the ice-bag, elevation, lead-water and laudanum, laxatives, and opium are used in the acute stage, and strapping is employed as the inflammation subsides. The treatment of the chronic form is the same as that for chronic orchitis.

Hydrocele (chronic hydrocele) is a collection of fluid in the tunica vaginalis testis. An enlargement of the testis can cause it, but in most instances the cause is unknown and no

signs of inflammation exist. The fluid is albuminous, but it does not coagulate spontaneously; it is thin, straw-colored, and may contain crystals of cholesterin. The testicle is at the lower and back part of the sac. The pyriform mass fluctuates, is translucent, grows from below upward, and the introduction of an exploring-needle causes the yellow fluid to flow out.

Treatment.—Simply tapping the sac with a trocar is only palliative, and, as air must run in as fluid runs out, suppuration may occur, which will be dangerous without drainage. Never tap a rigid sac. The injection of irritants should be abandoned, as it exposes the patient to serious danger because of inflammation occurring without provision for drainage. Hearn incises the sac, dries its interior with bits of gauze, swabs it out with pure carbolic acid, packs it with iodoform gauze, and dresses it antiseptically. The packing is removed in twenty-four hours and the wound is allowed to close. If the sac is rigid and will not collapse, either stitch it to the skin and pack it or excise a large portion of its parietal layer and insert a drainage-tube (Volkmann's operation). It has recently been proposed to tap the sac with a trocar and canula, to leave the canula in place as a drain for some days, and to dress antiseptically.

Congenital hydrocele is hydrocele through an unclosed funicular process into the tunica vaginalis. If the pelvis is raised the fluid runs back into the peritoneal cavity, from which it originally came. The *treatment* is a truss to obliterate the funicular process.

Infantile hydrocele is a collection of fluid in a funicular process and the tunica vaginalis, the funicular process being closed above, but not below. The *treatment* is to puncture the sac and to scarify the sac-wall with a needle.

Encysted Hydrocele of the Cord.—In this variety the funicular process is obliterated above and below, but it is

patent between these two points, and fluid collects. The *treatment* is the same as that for infantile hernia. If this fails, incise and pack.

Funicular Hydrocele.—The funicular process is closed below, but is open above. Raising the pelvis causes the fluid to trickle back into the peritoneal cavity. The *treatment* is a truss.

Encysted hydroceles of the testicles and of the epididymis can occur. *Diffused hydrocele* of the cord is simply œdema of the cord. *Hydrocele of a hernia* is the distention of a hernial sac with peritoneal fluid.

Hæmatocele.—*Vaginal hæmatocele* is blood in the tunica vaginalis, the result of traumatism, a tumor, or the tapping of a hydrocele. There is a pyriform tumor, which fluctuates, but which gradually becomes firmer; the scrotum is livid, and the testicle is below and posterior to the tumor. The *encysted* form of *hæmatocele of the cord* is a hydrocele of the cord into which bleeding has occurred. The *diffused* form is due to extravasation of blood into the cellular substance of the cord. *Encysted hæmatocele of the testicle* is due to effusion of blood into an encysted hydrocele of the testicle. *Parenchymatous hæmatocele* is extravasation of blood into the substance of the testicle. The *treatment* of a recent case of vaginal hæmatocele is to put the patient to bed, support the scrotum, and apply an ice-bag over the testicle. If the swelling does not soon abate, incise, irrigate, and pack.

Varicocele is varicose enlargement of the veins of the pampiniform plexus. An irregular swelling exists in the scrotum and extends up the cord. This swelling feels like "a bag of earth-worms;" it exhibits a slight impulse on coughing; the scrotal skin and cremaster muscle are attenuated; the testicle lies at the bottom of the swelling and is softer and smaller than normal; the swelling diminishes on lying down and increases on standing or on making pressure over the

external ring. There is usually some discomfort, aching, or dragging in the testcle or the groin, and even neuralgic pain in the cord. There is sometimes mental depression and hypochondria. In treating varicocele, reassure the patient: tell him there is no real danger of impotence; order cold shower-baths, correct constipation and indigestion, give occasional tonics, and order the patient to wear a suspensory bandage. If the testicle becomes much atrophied, if the pain and the dragging are annoying, or if the mind is much depressed, operate (see p. 261).

XXXVI. AMPUTATIONS.

An amputation is the cutting off of a limb or a portion of a limb. Removal of a limb or a portion of a limb at a joint is known as "disarticulation." Amputation may be necessary because of the existence of severe injury, of gangrene, of tumors, of intractable disease of bones or joints, of ulcers which will not heal, of traumatic aneurysm, etc. A re-amputation may be required because of the existence of a defect or disease in the stump.

Classification.—Amputations are classified as follows: (1) As to time after the injury of operation: a *primary* amputation is performed soon after the occurrence of the accident—as soon as the sufferer reacts from shock, and before he develops fever; a *secondary* amputation is performed some time after the accident, suppuration having supervened (Stokes); and an *intermediate* amputation is performed during the existence of fever, but before the development of suppuration. (2) As to the situation, where the bone is divided or according to which joint is cut through. (3) As to the form and situation of the flap.

In performing an amputation, maintain rigid asepsis; completely remove the hopelessly-damaged portion; sacrifice as

little of the sound tissue as possible; prevent hemorrhage during the amputation, and carefully arrest it after the operation; have enough sound tissue in the flap to *cover* the bone, and enough skin to cover the muscles; and secure drainage at a dependent point.

Hemorrhage is prevented by the elastic bandage of Esmarch. In an ordinary case apply this bandage from the periphery to well above the line of the prospective incision, encircle the limb with the elastic band (not a thin tube), and remove the bandage. The bandage and band, which are asepticized before using, are applied to a limb wrapped with antiseptic towels. After the band has been applied the limb should not freely or forcibly be moved, because of the danger of tearing muscles which are firmly set by the compressing band. When elastic compression is used in an operation the surgeon should be very careful to tie *every visible vessel.* The paralysis of the small vessels induced by pressure often prevents bleeding, and unless their mouths be found and the vessels be tied secondary hemorrhage will occur. Secondary hemorrhage is the great danger from the Esmarch bandage, and paralysis or sloughing may also follow its use. If there be an area of suppuration or of gangrene or an extra-osseous malignant growth, do not apply the bandage as directed above. One bandage can be applied from the periphery to near the lower border of the area of growth or infection, and another, from near the upper border of this area, up the limb. The contents of the area (tumor-cells and fluids or septic products) are not squeezed into the circulation. In cases like the above many surgeons hold the extremity in a vertical position for five minutes, lightly stroking it toward the body with the hand, and at once apply the constricting band. Some surgeons prefer the tourniquet. To apply Petit's tourniquet, place the plates in contact, apply a small firm compress over the artery and a broad thick compress over

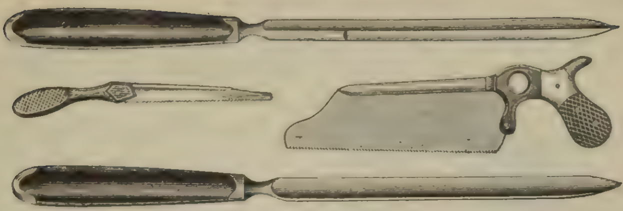


FIG. 172.—Catlin, Knife, and Saws for Amputations.

FIG. 173.—Modified Circular Amputation of the Forearm (Bryant).

FIG. 174.—Amputation of Arm by the Circular Method (Druitt).

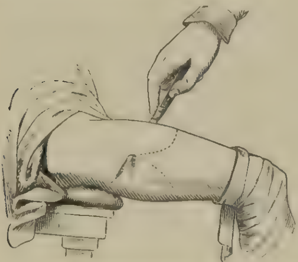


FIG. 175.—Amputation of the Thigh by Transfixion (Gross).

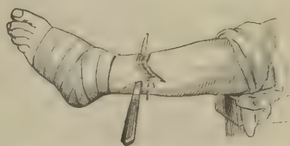


FIG. 176.—Amputation of the Leg by a Long Posterior Flap (Gross).

FIG. 177.—Sedillot's Amputation of the Leg (Wyeth).

FIG. 178.—Lisfranc's Amputation : first step (Guérin).

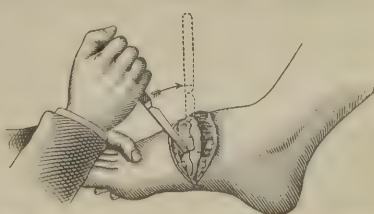


FIG. 179.—Lisfranc's Amputation : second step (Guérin).

the outer surface of the limb, buckle the tapes around the limb so that the plate is over the broad pad, and tighten the tourniquet by separating the plates with the screw. When a tourniquet is applied to arrest bleeding during transportation, bandage the limb, sew the compress pad to the bandage, and place the plates of the instrument over the pad. Signorini's horseshoe tourniquet may be used upon the brachial artery. In hip-joint and shoulder-joint amputations Wyeth's pins are passed, and after the limb is emptied of blood the band is fastened above them. These pins prevent the bands from slipping.

The instruments and appliances required are Esmarch's apparatus or tourniquet, amputating-knives, a bone-knife, scalpels, saws, a lion-jawed forceps, bone-cutting forceps, a periosteum-elevator, retractors of linen, dissecting, hæmostatic, and toothed forceps, a tenaculum, an aneurysm-needle, a probe, scissors, needles, ligatures, sutures of silkworm gut, dressings, bandages, and solutions. A retractor has two tails for the thigh and arm and three tails for the leg and forearm; it is made by taking a piece of muslin eight inches wide and twelve inches long and cutting tails on one side eight inches in length.

Methods of Amputating: Circular Method (Fig. 174).—The surgeon should stand to the right of the limb and use a long amputating-knife which cuts from heel to point. After an assistant has retracted the skin the operator divides the soft parts by a series of circular cuts. Do not cut at once to the bone, but divide the skin and subcutaneous tissues. At the retracted edge of the first cut divide the superficial muscles, and after these muscles retract divide the deep muscles. Incise the periosteum with a bone-knife, push up the periosteum with an elevator, and after the application of the retractors saw the bone. A periosteal flap can be made to cover the end of the bone, but it is unnecessary.

In this amputation is formed a cone whose apex is the bone and whose base is the skin-edge. In one form of circular amputation (*amputation à la manchette*) the retracted skin is cut by a circular sweep of the knife, a cuff of skin and subcutaneous tissue is freed and turned up, and the muscles are cut circularly at the edge of the turned-up cut (Fig. 180). The pure circular amputation is performed on the arm and the thigh; the amputation *à la manchette* is performed chiefly through the wrist and the lower forearm.

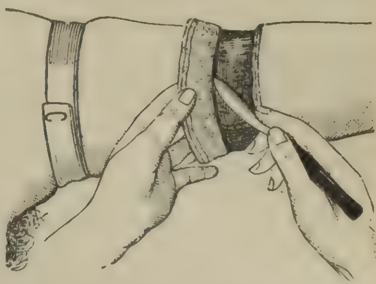


FIG. 180.—Circular Amputation: dissecting up the skin-flap (Esmarch).

Modified Circular Method.—In this operation the circular skin-cut may be modified by making a vertical incision to join the first wound, the muscles being cut by a circular sweep or by making two vertical skin-incisions. Liston's modification consists in dissecting up two short semilunar integumentary flaps and in dividing the muscles circularly This is known as the "mixed method" (Fig. 181). The modified circular can be used upon the thigh, the leg, the arm, and the forearm.

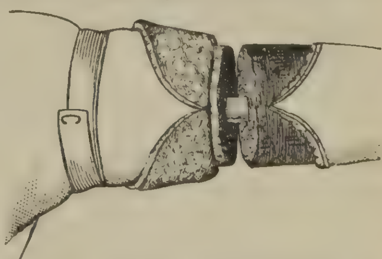


FIG. 181.—Modified Circular Amputation: skin-flaps and circular through muscles (Esmarch)

Elliptical Method.—This method stands midway between the circular operation and the operation by a single flap. An elliptical incision is made through the skin and subcu-

taneous tissues, the tissues are pushed up or turned back, and the muscles are divided circularly or cut partly by transfixion. This method is employed in certain disarticulations.

Oval or Racket Method.—In an *oval* amputation the incision through the skin and subcutaneous tissue is an oval with a pointed end or a triangle, and the other parts down to the bone are cut from without inward. When a longitudinal incision down to the bone (Fig. 184, A, B) extends from the point of the oval (*a*, *b*), the operation is called the "racket" amputation. If the longitudinal cut joins a circular cut, the operation is known as a "T" amputation. The oval or racket operation is performed at the metacarpo-phalangeal, metatarso-phalangeal, and shoulder-joints; the T operation may be performed at the hip-joint.

Flap Method.—A flap may be composed of *skin* only or of both *skin* and *muscle*, but the skin must always be cut longer than the muscle, so that the latter will be covered by it. A flap containing much muscle heals badly, but the best flap has a moderate amount of muscle (enough skin to cover the muscle and enough muscle to cover the bone). Flaps may be *single* or *double*. Double flaps may be *lateral* or *antero-posterior*, *square* or U-*shaped*, *equal* or *unequal*, and they may be cut by *transfixion* (Fig. 175), by cutting from without inward, by dissection, or by cutting the skin from without inward and the muscles by transfixion. When an amputation is completed, irrigate, tie the main vessels, pull down the nerves and cut them off, smooth the flaps, take off the constricting band, and after arresting hemorrhage apply sutures. In some cases the deep parts are stitched with a continuous catgut ligature and the superficial parts are closed with silkworm gut; in other cases the deep parts are not stitched at all, the skin alone being sutured with silkworm gut. Drainage-tubes should be used except in amputations of the fingers and toes.

Special Amputations: Fingers and Hand.—In amputating the thumb and index finger, save every possible scrap of tissue. In either of the other fingers, if it be necessary to amputate above the middle of the middle phalanx, the attachment of the flexor tendons will be cut off and the finger will be liable to project directly backward, so that it is better with these fingers either to disarticulate at the metacarpal joints or to stitch the flexor tendons to the periosteum. The flexor tendons have fibrous sheaths extending from the proximal end of the distal phalanx to the metacarpo-phalangeal articulations, these sheaths being thin and collapsible opposite the joints, but being thick and rigid opposite the shafts of the bone. The fibrous sheath is known as the *theca*, and when it is cut in an amputation it should be closed, otherwise it may carry infection to the palm of the hand. The theca does not exist over the distal phalanx, and it is not distinctly visible over the joint between the distal and middle phalanges. To effect closure over the shaft of a bone, strip up the periosteum and pass catgut sutures vertically through the theca and the periosteum (Treves). In amputation of the fingers and the thumb an Esmarch bandage is unnecessary, though pressure may be made upon the arteries in the wrist. Ligatures are often unnecessary. Close with a very few sutures, so as to favor drainage between the threads.

The distal phalanx is best removed by a long palmar flap (Fig. 182, A). The palmar flap (A) is marked out by cutting through the skin and subcutaneous tissue. The incisions are next carried to the bone, the flap is dissected from the bone, the finger is strongly flexed, a transverse incision (B) is carried across the dorsum on a level with the base of the third phalanx, the soft parts are pushed back, the joint is opened, the lateral ligaments are

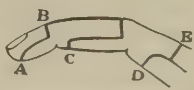


FIG. 182.—Amputation of the Finger.

cut from within outward, the third phalanx is forcibly extended, and the remaining structures are cut from below upward. The middle phalanx can be removed by the same method (C). The proximal phalanx can be removed by a long palmar flap or by a long palmar and a short dorsal flap (D, E).

Disarticulation of a metacarpo-phalangeal joint is best performed by the oval or racket method. The incision upon the dorsum (A) is begun just above the head of the metacarpal bone, is carried down to beyond the base of the phalanx, and involves the skin only (Fig. 183). One incision sweeps around the finger at the level of the web, going only through the skin (B); the finger is extended and the palmar cut is carried to the bone; each lateral incision is carried to the bone while the finger is bent in the opposite direction, the flaps are dissected back to the joint, the finger is strongly extended, the joint is opened from the palmar side, and disarticulation is effected. Cutting off the head of the metacarpal bone improves the appearance of the stump but weakens the hand, hence in a working-man it must not be done. If it is necessary to remove a metacarpal bone, the incision (C) is made from the carpo-metacarpal joint.

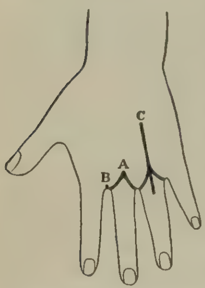


FIG. 183.—Disarticulation of a Metacarpo-phalangeal Joint.

Amputation of the thumb through its distal or proximal phalanx is performed identically as is an amputation of a finger. Amputation of the thumb with a portion or the whole of its metacarpal bone is performed by the oval or racket incision.

Amputation at the wrist-joint can be done by the circular method or by a double flap. In the double-flap amputation (Fig. 98, 1, 2) a dorsal flap is made by carrying a semi-

lunar skin-incision between the styloid processes; the skin is lifted up, the wrist is forcibly flexed, the joint is opened by a transverse cut, and a long semilunar palmar flap is made by dissection, which flap includes only the skin and fascia.

Amputation through the forearm may be done as a circular (Fig. 174), a modified circular, or a flap operation. An excellent plan is to make a semilunar dorsal skin-flap (Fig. 98, 3) and a semilunar skin-flap on the flexor surface (Fig. 98, 4). The flaps are raised, the muscles are cut circularly (Fig. 173), the interosseous space is cleared with the knife, a three-tailed retractor is applied, the periosteum is pushed up, and the bones are sawn half an inch above the flap. In sawing the bones, start the saw upon the radius, draw it from heel to point, make a furrow on the radius and ulna, and saw both bones together. After sawing, cut away any irregular edge with bone-pliers. In the lower third Teale's amputation may be done, the dorsal flap being the long one (Fig. 97, 1). In Teale's amputation rectangular flaps are made. The long flap is equal in width and length to one-half the circumference of the limb at the point where it is to be sawn. The short flap is equal in width to the long flap, but is only one-fourth its length. The two longitudinal cuts are at first taken only through the skin, but the two transverse cuts go at once to the bone. The flaps are dissected up from the interosseous membrane and the bone. In the middle or the upper third of a fleshy arm two semilunar skin-flaps can be cut from without inward, and the muscle can be cut by transfixion.

Disarticulation of the elbow-joint can be done by the elliptical method or by a long anterior flap and a short posterior flap. In the latter operation the forearm is partly flexed and a skin-cut marks out a long anterior flap, the knife being entered opposite the external condyle and being withdrawn one inch below the internal condyle (Fig. 98, 5).

The muscles, which are bunched forward, are cut by transfixion. A posterior semilunar flap is made (Fig. 100, 1), which separates the attachments of the radius, the ulna is cleared, and the triceps is cut at its insertion (Bell). Gross advocated sawing through the olecranon and the inner trochlear surface.

Amputation of the arm is best performed by marking out with a knife two equal semilunar antero-posterior flaps, the knife cutting through the skin, the muscles then being transfixed with a long knife (Fig. 99, 1). Teale's method is shown in Figure 98 (6). The circular or the modified circular amputation may be performed.

Disarticulation at the Shoulder-joint.—In this operation Wyeth's pins must be passed to prevent hemorrhage. The anterior pin is entered at the middle of the lower margin of the anterior axillary fold, and emerges one inch within the tip of the acromion. The posterior pin is entered at a corresponding point on the posterior axillary fold, and emerges more posteriorly than the first pin and an inch within the tip of the acromion.

Larrey's Operation.—In this method of shoulder-joint disarticulation the limb is held from the side and an incision is made down to the bone, the incision beginning just below and in front of the acromion and running vertically for four inches down the outer surface of the arm (Fig. 184, A, B). From the centre of this incision an oval incision is carried around the arm, the inner aspect of the oval reaching as low as the lower end of the vertical cut (a, b). The oval incision at first involves only the skin and subcutaneous tissues. The anterior structures are divided close to the bone, and the posterior structures are next cut. To disarticulate, cut the capsule transversely upon

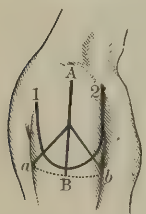


Fig. 184.—Amputation at the Shoulder-joint: A, B, Larrey's operation; 1, 2, Dupuytren's operation.

the head of the bone; while the arm is rotated outward cut the subscapularis, and while the arm is rotated inward cut the supraspinatus and infraspinatus and the teres minor. Cut away any tissue holding the humerus to the body, cut away hanging nerves, capsule-fragments, and tissue-shreds, and sew up the wound vertically. Bell advises an oval incision without a racket handle (Fig. 98, 7). Spence used an anterior racket incision.

Dupuytren's Method.—In Dupuytren's shoulder-joint disarticulation a U-shaped flap is marked out by a skin-incision (Fig. 184, 1, 2; Fig. 97, 3). In the right shoulder the arm is carried across the chest; the knife is entered at the root of the acromion, follows the margin of the deltoid, and is withdrawn at the coracoid process, the arm being gradually abducted and pulled off from the chest. In the left shoulder the procedure is reversed (Treves). The knife now cuts through the deltoid and raises a flap composed of this muscle, the shoulder-joint is exposed, and disarticulation is effected as in Larrey's method. The knife is passed down back of the bone and a short internal flap is cut. Lisfranc's amputation is by transfixion with the formation of an anterior and a posterior flap, and can be performed very rapidly, but only a most skilful surgeon should attempt it.

Amputation of the Toes and the Foot.—Only in the great toe is *partial* amputation performed, and it is performed by a long plantar flap as is done in the finger. Amputation at the metatarso-phalangeal joints is performed by an oval or racket incision (Fig. 185). Amputation of a toe with removal of its metatarsal bone is shown in Figure 185.

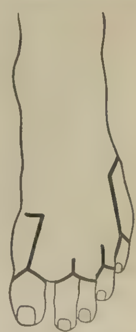


FIG. 185. Amputation of Metatarsal Bones.

Amputation at the Tarso-metatarsal Articulation.—*Lisfranc's Method* (right foot, after Treves).—Begin an incis-

ion on the outer border of the foot, behind the tubercle of the fifth metatarsal bone; carry the incision forward one inch and sweep it across the foot half an inch below the tarso-metatarsal articulations; bring the incision to the inner edge of the foot, half an inch in front of the tarsal articulation of the big toe, and carry the cut straight along the inner margin of the foot until it reaches a point three-fourths of an inch above the articulation of the metatarsal bone of the great toe. A semilunar dorsal skin-flap is thus formed (Figs. 178, 179). After the skin-flap is dissected back for a quarter of an inch the tendons are divided, and the flap, which now contains all the soft parts, is dissected back to *above* the joint. A long plantar flap is cut, reaching from the origin of the first flap to the necks of the metatarsal bones. The skin-flap is dissected up until the hollow behind the heads of the metacarpal bones is reached, when, with the toes in extension, the tendons are cut across and a flap composed of all the soft parts is dissected up to above the tarso-metatarsal joint. The joint is opened from the outer side according to the following rule: In separating the fifth metatarsal, direct the edge of the knife toward the distal end of the first metatarsal; in separating the fourth metatarsal, direct the knife toward the middle of the first metatarsal; in separating the third metatarsal, carry the knife almost directly across. Figure 186 shows the line of Lisfranc at the tarso-metatarsal articulation. The separation is facilitated by bending down the front of the foot, and at the same time the tendons of the peroneus brevis and tertius are divided. Open the joint between the first metatarsal and the inner cuneiform bone, turning the knife toward the middle of the shaft of the fifth metatarsal,

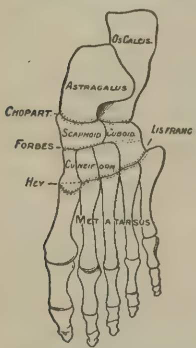


Fig. 186.—Lines in Amputations of the Foot (Gross).

and at the same time divide the tibialis anticus muscle. Treves says that in disarticulation of the second metatarsal the knife is to be held as a trocar, it is to be thrust between the base of the first and second metatarsal bones until the point strikes bone (Fig. 178), and is then to be raised to a perpendicular and the cut is to be made toward the external malleolus to sever the ligament of Lisfranc (Fig. 179). Divide any remaining ligaments, and also the tendon of the peroneus longus muscle. The skin-incisions in the *left* foot are begun on the inner side, and in disarticulating the tarsal joint of the great toe is first opened.

Hey's Method.—In Hey's method the incision is practically the same as that for Lisfranc's amputation (Fig. 98, 8, 9). The four external metacarpal bones are disarticulated, but the first metatarsal is removed by sawing a portion of the internal cuneiform bone. Guérin advised sawing all the bones across. Skey advised the division of the head of the second metatarsal. Figure 186 shows the line of Hey.

Amputation through the Middle Tarsal Joint.—*Chopart's Amputation.*—Make a transverse incision through the skin of the instep, two inches below the ankle-joint; cut the tendons and muscles, expose the tarsus (Fig. 97, 4, 5), and make on each side a small longitudinal incision reaching to below and in front of the corresponding malleolus. The flap thus formed is retracted. The plantar flap is made as in Lisfranc's amputation. Open the astragalo-scaphoid joint, then the calcaneo-cuboid joint, and disarticulate. Figure 186 shows the line of Chopart. In *amputation through the tarsus* Forbes of Toledo advises making flaps as in Chopart's amputation, disarticulating the scaphoid from the cuboid bones, and sawing through the cuboid. Figure 186 shows the line of Forbes.

Amputation at the Ankle-joint.—*Syme's Method.*—The foot is held at a right angle to the leg, and a skin-incision is

carried, from just below the external malleolus, straight across or a little backward across the sole to a corresponding point on the opposite side (Fig. 98, 10, 11). Do not take this incision near to the inner malleolus, as to do so will endanger the posterior tibial artery. The incision is carried to the bone, the flap being pushed back and separated from the bone by means of a strong knife and the thumb-nail until the tuberosity of the os calcis has been reached. The foot is now extended and a transverse cut is made across the dorsum, joining the two ends of the first incision (Fig. 98, 10, 11); the ankle-joint is opened, the lateral ligaments are cut, disarticulation is effected, and the foot is finally completely removed by severing the tendo Achillis. A thin piece of bone including both malleoli is sawn from the tibia and fibula. The flap is perforated posteriorly to secure drainage.

Pirogoff's Method.—In this method of ankle-joint amputation the incisions are the same as those for Syme's amputation. Do not dissect the flap from the posterior portion of the os calcis, but saw off this bony projection obliquely and leave it adherent to the tissues. The saw is used after disarticulation of the ankle-joint; it is passed behind the astragalus, cutting downward and forward. The ends of the tibia and fibula are sawn off, and the sawn os calcis is brought into contact with the sawn tibia and fibula.

Amputations of the Leg.—In amputations of the leg by the *long anterior flap*, cut through the skin (Fig. 99, 4, 5), dissect up the anterior muscles with the flap, and cut all the posterior tissues with a single transverse sweep. In amputation by *rectangular flap* Teale's method is very useful (Fig. 98, 12, 13).

Sedillot's leg-amputation (Fig. 177) is by a long external flap. A longitudinal incision is made along the inner edge of the tibia, the tissues are drawn toward the fibula,

a knife is introduced and passed to the outer edge of the tibia, just touching the fibula, and is brought out posteriorly, thus transfixing the calf-muscles and cutting an external flap. A convex incision is made on the inner side, the bones are cleared and are sawn one inch above the flaps, half an inch more being taken from the fibula than from the tibia, and the tibia being bevelled anteriorly.

Modified Circular Amputation of the Leg.—Cut semilunar skin-flaps (Fig. 99, 6, 7), lay them back, and cut circularly to the bone at the edge of the turned-up flap. Another method of modified circular amputation is by adding to the circular cut a vertical incision down the front of the leg. In sawing the bones of the leg, the surgeon, who stands on the outer side of the right leg or on the inner side of the left leg, divides the fibula first, and at a higher level than the tibia, and bevels the anterior surface of the tibia. In sawing the left fibula the saw points to the floor; in sawing the right fibula it points to the ceiling.

Amputation of the Leg by a Long Posterior and a Short Anterior Flap.—In this operation a posterior U-shaped flap is made, equal in length and breadth to the diameter of the limb. The skin-incision is begun one inch below the point where the bone is to be sawn, and behind the inner edge of the tibia, and is carried to a point posterior to the peronei muscles. The gastrocnemius muscle is divided transversely at the level of the flap, the soft parts on either side in the line of the flap being cut to the bone. Through these vertical cuts the muscles are lifted from the bones and are divided through their lower part by cutting from within outward. The anterior flap is formed by making a semilunar skin-flap and by cutting the muscles across at its retracted edge (Fig. 176). *Amputation of the leg by lateral flaps* is not a popular operation, as it offers too much encouragement to subsequent protrusion of the bone.

Amputation just below the Knee.—The seat of election is one inch below the tuberosities. No muscle is needed in the flap. Cut two flaps of skin, equal in size and semilunar in shape, these flaps beginning anteriorly two inches below the tuberosity of the tibia. One flap is antero-external and the other is postero-internal (Fig. 99, 6, 7). The flaps are pulled up, the anterior muscles are cut as high up as possible, and the posterior muscles are cut through the middle of the portion exposed (Bell). The bone is sawn one inch below the tuberosity.

Disarticulation of the Knee.—In disarticulation by the long anterior flap (Carden's amputation; Fig. 97, 8), make a long anterior skin-flap, incise the ligament of the patella, turn up the flap with the patella, open the joint, and make a short posterior flap by cutting from within outward and downward. The knee may be disarticulated by means of a long anterior and a short posterior flap (Fig. 97, 6, 7).

Amputation through the Femoral Condyles.—*Syme's Method by a Long Posterior Flap* (Figs. 99, 100, 4, 8).—Carry a skin-incision with a very slight downward curve from one condyle to the other, across the middle of the patella. Cut down to the bone, retract the flap, and cut the quadriceps above the patella. Insert a long knife at one angle of the wound, pass it back of the femur, and make it emerge at the opposite angle, cutting a posterior flap eight inches long. Retract the posterior flap, clear for sawing, and section the condyles horizontally.

Amputation of the Thigh.—In thigh-amputation in the *lower third* either a flap or a circular operation may be performed. In a double-flap operation a semilunar skin-incision should be made from without inward and the muscles should be cut by transfixion (Fig. 187). In the lower third Teale's flap (Fig. 97, 9, 10) or the long anterior flap may be employed. The amputation by a long anterior flap consists in making

a lengthy skin-flap, reflecting it, cutting the anterior structures to the bone, again entering the long knife at one angle of the incision, pushing it back of the femur, bringing it out at the other angle, and cutting the structures back of the bone directly backward (Fig. 98, 16). Bell amputates by a long anterior semilunar flap and a short posterior flap. In amputations in the *upper two-thirds* of the thigh the best plan is to mark out equal anterior and posterior semilunar skin-flaps, enter the long knife at one angle of the anterior flap, bring it out at the other angle, and cut the muscles by transfixion (Fig. 175). Cut the posterior flap in the same manner. Some surgeons prefer a long anterior semilunar flap and a short posterior semilunar flap. The pure circular is not adapted to the thigh.

FIG. 187.—Amputation of the Thigh (Bryant).

Disarticulation of the Hip-joint.—In the *bloodless method of Wyeth* (Fig. 188) the band of the Esmarch apparatus is held up by Wyeth's pins, the outer pin being inserted one and a half inches below and a little internal to the anterior superior spine of the ilium, and brought out just back of the great trochanter. The inner pin is entered one inch below the level of the crotch, internal to the saphenous opening, and it emerges one and a half inches in front of the tuberosity of the ischium. The hip is brought well over the edge of the table, a circular incision is made down to the deep fascia six inches below the constricting band, and joined by a longitudinal skin-cut reaching from the incision to the level

of the circular incision, and the cuff is reflected to the level of the lesser trochanter. Cut the muscles by a circular sweep at the level of the retracted cuff, open the capsule freely, cut the cotyloid ligament posteriorly, have the thigh bent upward, forward, and inward to dislocate the head of the bone, and, using the thigh as a handle, incise the round ligament and remove the limb. After ligating the vessels and introducing tubes the flaps are sewn together vertically.

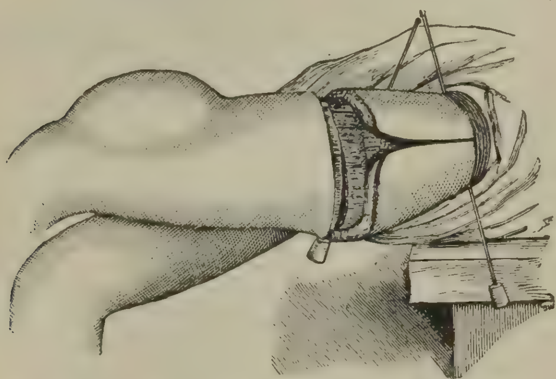


FIG. 188.—Amputation at the Hip-joint: Wyeth's bloodless method.

The old transfixion operation is practically extinct. A T-*amputation* may be employed. It consists of an external straight incision down to the bone, starting over the great trochanter, down the outer side of the limb, and a circular incision through the skin five inches below the constricting band, the muscles being cut by a circular sweep at the level of the retracted skin. This method affords easy access to the joint. The bloodless method of Wyeth, as applied to the hip-joints and shoulder-joints, is one of the most notable modern advances in the art of surgery.

BRONCHOCELE, OR GOITRE.

A goitre is an enlargement of the thyroid gland not due to malignant tumor or to inflammation. Goitre may affect a portion of one lobe, both lobes, or both lobes and the isthmus, and it may occur sporadically or endemically. In Switzerland it is very common. Among the alleged causes are the playing of wind-instruments, the drinking of snow-water, and the use of water impregnated with the salts of lime. Hereditary influence is frequently noted. The forms of goitre are as follows: *Simple hypertrophy*, a hypertrophy of the gland-tissue, usually symmetrical; *cystic goitre*, in which cysts form in hypertrophied glands, or rarely in non-hypertrophied thyroids, the cysts being either single or multiple, being due to mucoid or colloid degeneration, and containing a fluid sometimes clear and thin, sometimes viscid, and often coffee-ground in character; and *fibrous goitre*, a fibrous induration which is apt to arise in old bronchoceles, and which may pass into a calcareous condition.

The *symptoms* are—congestion of the head and neck from enlargement of veins; occasionally cerebral symptoms (anæmia, syncope, even convulsions) from pressure on carotids; irritation of recurrent laryngeal nerve (causing spasm of the glottis or laryngeal paralysis); compression of the trachea (dyspnœa). Rapidly-growing goitres (acute goitres) are often fatal; slow-growing goitres are rarely fatal. A goitre moves with the gullet in swallowing.

Treatment.—Medical treatment of goitre is of little use. Iodide of potassium and arsenic internally have been advised; ointment of red oxide of mercury locally is advocated by some writers. The only hopeful methods are surgical. Cystic goitres may be aspirated and injected with a solution of iodine. Electrolysis may benefit a soft goitre, the negative pole being pushed into the growth, the positive pole being

applied to its surface. Ligation of the thyroid arteries has been recommended by some surgeons. The radical operation is the removal of the mass (thyroidectomy). It is a bloody and dangerous operation, and during its performance and for a time after its completion the patient is liable to sudden and fatal collapse. The entire gland must not be removed: a bit of it is always allowed to remain, otherwise cachexia strumipriva (or myxœdema) may arise.

Exophthalmic or Pulsating Goitre.—In this condition there are palpitation of the heart, rapid pulse, protrusion of the eyeballs, and enlargement of the thyroid gland. It is a vaso-motor ataxia (Cohen) resulting from disease of the sympathetic system. Von Graefe's sign is retraction of the upper lids and a failure of the lids to follow the eyes when looking down. A systolic bruit can be heard over the goitre. The goitre is usually bilateral, but may be unilateral, and it may be intermittent or persistent. Emotional causes are influential in its production. Nystagmus, tremor, flashes, hæmoptysis, hæmatemesis, and mental disturbances are apt to occur. Exophthalmic goitre may be treated by aconite, belladonna, digitalis, or strophanthus. Electricity may be used. Extirpation has been tried, but it is scarcely considered advisable.

XXXVII. ASEPSIS AND ANTISEPSIS.

Surgical cleanliness may be obtained by either the *aseptic* or the *antiseptic* method. In the aseptic method heat, chemical germicides, or both are used to cleanse the instruments, the field of operation, and the hands of the surgeon and his assistants. After the incision has been made no chemical germicide is used, the wound being simply sponged with gauze sterilized by heat; if irrigation is necessary, boiled water is used, and the wound is dressed with gauze

which has been rendered sterile by heat. The aseptic method should be used only in non-infected areas. The elimination of chemical germicides lessens serous flow and often enables the surgeon to dispense with drainage-tubes. If irrigation is not practised and the wound is dressed with dry gauze, the procedure is said to be by the "dry" method. In the antiseptic method the same preparations are made for the operation as in the aseptic method, but during the operation sponges impregnated with a chemical germicide are used, and the wound is dressed with gauze containing corrosive sublimate. If the wound is not flushed with a chemical germicide, and is dressed with dry gauze, the operation is said to be by the "dry" antiseptic method. The antiseptic method is always preferred in infected areas. Dry dressings are usually preferable to moist dressings, because they are more absorbent and do not act as poultices, and dry dressings may be used even when the wound has been flushed.

Preparations for an Operation.—The surgeon and his assistants remove their coats, roll up their sleeves, and envelop their bodies in aseptic or antiseptic sheets to protect the patient and themselves. The hands and forearms are scrubbed with soap and hot water. There is nothing equal to the ethereal soap of Johnson, which is a solution of castile soap in ether. The brush employed is kept constantly in a 1 : 1000 solution of corrosive sublimate. The nails are cut short, are cleansed with a knife, and the hands are again scrubbed. The hands are dipped in a hot solution of corrosive sublimate, and with the forearms are scrubbed for at least a minute, the nails receiving especial care; they are then dipped for one minute into pure alcohol and are again bathed with the mercurial solution. Kelly disinfects the hands by washing them with soap and water, dipping them in a solution of permanganate of potas-

sium (a saturated solution in boiling distilled water), and decolorizing them in a saturated solution of oxalic acid.

Instruments are disinfected by boiling for fifteen minutes in a 1 per cent. solution of carbonate of sodium and then rinsing them in a 5 per cent. solution of carbolic acid. They are kept in trays containing boiled water. Instruments can be disinfected satisfactorily by keeping them for fifteen minutes in a 5 per cent. solution of carbolic acid. Instruments with handles of wood must not be boiled, but they are disinfected by carbolic acid. After the completion of the operation the instruments should be scrubbed with soap and water, boiled, and dried. Marine sponges are rarely used, small pieces of sterilized or antiseptic gauze being preferred. In the abdomen Ashton's aseptic gauze pads are employed. These pads are about ten inches square, and are made of a number of folds of gauze stitched loosely at the edges. Whenever possible, give the patient some days' rest in bed before a severe operation, and place him on a diet nutritious but not bulky. The night before the operation give a saline cathartic, and the morning of the operation employ an enema. Whenever possible, give a general warm bath the day before. The evening before the operation scrub the entire field and well clear of it with soap and water, shave if necessary, wash with ether, scrub well with hot corrosive-sublimate solution (1 : 1000), apply a layer of moist corrosive-sublimate gauze, and place over this dry antiseptic gauze, a rubber dam, and a bandage. On removing the dressings to perform the operation, scrub the part again with hot mercurial solution. In emergency cases disinfection must be practised just previous to the operation.

The favorite ligature material is catgut, which is well prepared by boiling in alcohol. Another method is to take the raw catgut, soak it in ether for twenty-four hours, soak it for twenty-four hours in an alcoholic solution of corrosive

sublimate (1 : 500), wind it on sterilized glass rods, and place it for keeping in ether or in alcohol. Fowler's catgut is carried in tubes of alcohol hermetically sealed, each tube holding twelve ligatures. Johnson's quick method of preparing catgut is as follows: Place it for twenty-four hours in ether; at the end of this period place it in a solution containing 20 grains of corrosive sublimate, 100 grains of tartaric acid, and 6 ounces of alcohol. The small gut is kept in this for ten or fifteen minutes, the larger gut from twenty to thirty minutes, but never longer. It is placed for keeping in a mixture containing 1 drop of chloride of palladium to 8 ounces of alcohol. This gut is strong and reliable. At the time of operation the gut is placed in a solution two-thirds of which is 5 per cent. carbolic-acid solution and one-third of which is alcohol. Chromicized gut will not be absorbed so readily as other gut. It is prepared by adding 200 parts by weight of catgut to 200 parts of carbolic acid, 2000 parts of water, and 1 part of chromic acid. After remaining in this solution twenty-four hours it is transferred for permanent keeping to ether or to alcohol. Sutures of silk should be well boiled before using. A convenient method of preparation is to wind the silk on a glass spool, place the spool in a large test-tube, close the mouth of the tube with absorbent cotton, introduce the tube into a steam sterilizer, and keep it there for one hour. These tubes are carried in wooden boxes sealed with rubber corks. Silkworm gut is prepared by placing it in ether for forty-eight hours and in a solution of corrosive sublimate (1 : 1000) for one hour. It is carried in a long tube filled with alcohol. A few minutes before using, the gut is placed in carbolic acid and alcohol (two-thirds of a 5 per cent. solution of acid, one-third of alcohol). *Silver wire* is prepared by boiling.

Dressings are made of cheese-cloth. This cloth is boiled in a solution of carbonate of soda, rinsed out, and dried;

it is then soaked for twenty-four hours in a solution containing 1 part of corrosive sublimate, 2 parts of table-salt, and 500 parts of water. It is kept in jars, and it may be maintained moist or dry.

Sterilized gauze is prepared by boiling the material in soda, rinsing, and either boiling it for fifteen minutes or placing it in the steam sterilizer for the same time.

Iodoform gauze is useful for packing and for dressing foul wounds. It is prepared as follows: Make an emulsion composed of equal quantities by weight of iodoform, glycerin, and alcohol, and add corrosive sublimate in the proportion of 1 part to the 1000 of the mixture. This mixture stands for three days. Take moist bichloride gauze, saturate it with the emulsion, let it drip for a time, and keep it in sterilized and covered glass jars (Johnson). Lister's cyanide gauze (double cyanide of zinc and mercury) must be dipped into a corrosive-sublimate solution (1 : 2000) before using. All antiseptic appliances can be bought ready prepared from reliable firms. Small wounds in which drainage is not employed may often be dressed by laying a film of aseptic absorbent cotton over the wound and applying, by means of a clean camel's-hair brush, iodoform collodion (grs. xlviij to ℥j).

When a wound is dressed with gauze a rubber dam must always be laid over the dressings, so as to diffuse the discharge and prevent it from coming rapidly to the surface. Drainage is obtained when needed by rubber tubes or by strands of horsehair, silkworm gut, or catgut, but these three last-named materials will not drain off pus. Dressings must be changed as soon as soaking is apparent. Stitches may usually come out about the sixth day. In large wounds only a portion of them are taken out at one time, the balance being allowed to remain for a couple of days longer. When a stitch begins to cut it is doing no good, and it should be removed, no matter how short a time it has been in place.

Preparation of Marine Sponges.—Beat out the dust; place them for forty-eight hours in a solution of hydrochloric acid (15 per cent.); wash them out with water; place them for one hour in a solution of permanganate of potassium (ʒiij to 5 pints of water); soak for four hours in a solution containing 10 ounces of hyposulphite of sodium, 5 ounces of hydrochloric acid, and 3 pints of water; wash with running water for six hours. Keep the sponges in a jar containing corrosive-sublimate solution (1 : 1000). After using, wash in hot water, soak for half an hour in a solution of sodium carbonate (1 : 32), wash in hot water, and replace in corrosive sublimate. A marine sponge inevitably becomes foul in its interior, and should not be used.

To clean the vagina or rectum, use a sponge soaked with creolin and Johnson's ethereal soap (1 : 16), and subsequently irrigate with corrosive-sublimate solution.

Senn's Decalcified Bone-chips.—Take the shaft of the tibia or femur of a recently killed ox, saw it into portions two inches in length, remove the marrow and periosteum, and place the bits of bone in a 15 per cent. solution of hydrochloric acid. Change the solution every twenty-four hours. In from two to four weeks the bone will be decalcified. Wash in distilled water, place the bone in a dilute solution of potash to neutralize the acid, and then immerse for twenty-four hours in distilled water. The portions of bone are now cut into strips in the direction of the long axis of the segments, each strip being three-quarters of an inch wide and being sliced up into bits one millimetre thick. These chips are kept in an alcoholic solution of corrosive sublimate (1 : 500).

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